UNITED STATES ARMY APRIL 1972

AVIATION DIGEST

Accurate and thorough mishap investigations—how important are they to aviation safety?
see page 36

UNITED STATES ARMY AVIATION DIGEST

DIRECTOR OF ARMY AVIATION, ACSFOR DEPARTMENT OF THE ARMY
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MG Allen M. Burdett Jr.
ASST COMDT, U. S. ARMY AVIATION SCHOOL
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The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine, and other related data.

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VIEWS FROM READERS

Dear Sir:

I read the "Longest Mission" which appeared in the February issue of the AVIATION DIGEST. I am not in agreement with its author, Captain Samuel C. Raines . . . Tabriz is not in Turkey but in Iran.

Metin Okcu
Major, Turkish Army
USALMC LEDC 72-2
Fort Lee, VA 23801

• You are correct. Tabriz is in Iran. The DIGEST regrets this error.

Dear Sir:

The enclosed was submitted to me by Specialist Wiley Marks, who is a member of B Company, 704th Maintenance Battalion, 4th Inf Div (Mech). I'm sure you can detect his sincerity. I'm sending it to you with the thought in mind that too often we lose the benefit of items of interest because not every one is capable of writing in the polished manner of your usual articles. I include myself in this category.

Would it be worthwhile to publish this article as it is with a minimum of editing?

Harry E. Ziegler
DAC
Butts AAF Operations
Ft. Carson, CO 80913

• It sure is worthwhile. Too bad that everyone doesn't feel as sincere about safety as the following indicates that Specialist Marks does:

What have you got against another man enjoying the happiness of living?

When you're working on aircraft, it is very important to watch where your metal particles and loose rivets fall!

When you're working around the intake of a turbine engine, do you realize the damage that one loose rivet can do to that engine? Be sure to put a cover over the intake and clean up around the area when you get through. Never depend on anyone else to clean up after you. When you have a sand particle separator that needs a patch or work done on it, remember the amount of air that is being sucked through it into the turbine engine. Be sure to wash *all* the metal shavings and particles out of it. Now that the job is done, where are your tools?

Did you ever stop to think just how fast that tail rotor drive shaft is turning? You just happened to leave a screwdriver under it when you finished a job. They wanted the aircraft now and you wanted them off your back. You worked as fast as you could, shut the cowling and checked your tools: drill, rivet gun, bucking bar, hammer, clecos, cleco pliers and a punch. Everything is there, so you take off. Now you never in your life took out a screwdriver to patch an aircraft. What about this time? You may have just been the cause of the crewmen losing their lives because of something you would never do. When you finish a job take your time to check for tools every place you worked.

Do you like to bleed all over the place? Then why, when you're cutting with shears, do you let the pieces of metal fly all over the place. Be careful and watch what you're doing when you're cutting metal.

Most people really enjoy their eyesight. It's a very nice thing to have. When you are using the grinder your purpose is to remove metal from metal. That, with common sense, should tell you that the metal particles have to go somewhere and with no goggles your eyes are as good a place as any for them.

FOD is everyone's concern. Make a good visual check of your area of operation, then be quick about cleaning up. Be very careful and concerned about the job you have to do.

Sir:

The report entitled "Aviation Safety in Combat" in the February issue of the DIGEST was very interesting. It was a very pleasant surprise to note that we have a large number of commanders who are willing to look at the problem, even in combat, and admit that there is a problem. Admitting the problem is the first step to solving the problem. In the past, we have sometimes had the attitude that anything is justified if we tie it to the magic words of "mission oriented." There has been a tendency to talk about our capabilities and play down our limitations. Then when the time comes to produce, the monkey goes on the back of the individual aviator and the lower level commander to make these dreams come true.

One item was included in the report that I have never seen in print before. This was question 33, "Present regulations which permit zero/zero takeoffs should be changed to require that takeoff weather conditions be equal to the landing minima for the departure airfield." The question could have been expanded to include 100 and ¼ and still have been valid. We have discussed this question in the past, not related to a combat environment but rather to routine peacetime missions. Many examiners, including myself, do not believe you can justify taking off on a routine

Continued on page 31

LOW LEVEL PROFICIENCY

With increased emphasis being placed on helicopter survivability in the mid-intensity conflict, the author discusses the problem of low level navigation and suggests that Army aviation energies be redirected toward the reestablishment of the individual aviator's nap-of-the-earth proficiency

Captain Carl A. Meyer

HISTORIANS WILL write that the "helicopter war" in Southeast Asia in the 1960s and early 1970s saw the full flowering of Army aviation. The helicopter found a niche in the scheme of battle and became a super weapon not unlike the horse cavalry or armored columns of earlier wars. Airmobile operations against a tenacious but unsophisticated enemy proved the value of heliborne warfare in stability type operations and did little to dampen early enthusiasm for airmobility on future battlefields. As is usual in such an era, many projections for future employment and development of the airmobile concept, the attack helicopter and the air cavalry were optimistic if not downright extravagant.

Only after the Laotian incursion of 1971 did this enthusiasm yield to the more guarded position that limited helicopter nap-of-the-earth operations are possible only on a highly mobile battlefield and not without predictable losses far higher than experienced in the Republic of Vietnam. But there remains a confidence that nap-of-the-earth techniques will allow penetrating and operating below sophisticated antiaircraft defenses such as are found in Europe or the Mideast. However, as the Vietnam war turns down and military planners turn to developing doctrine for a more "conventional" war, one thing becomes increasingly apparent. The Army aviator who fought so courageously and so well in Vietnam is poorly equipped and ill-trained to fly in the nap-of-the-earth environment.

Faced with the sobering prospect of encountering hardware as awesome as Chapparal, Vulcan and Redeye employed "up front" with the enemy maneuver elements, the Army aviator finds himself in a cockpit better equipped for flying airways than among the trees. And he has little or no experience navigating in what he has always considered a hostile environment.

The treetops, which most recently have been the exclusive haunt of the scout pilot, could well be the airways in a future conflict. The "deadman's zone" will extend from the treetops *up*. The presence of mobile radar-directed antiaircraft, enemy tactical air and an increased

density of small arms fire make the consideration of a safe emergency landing area secondary to the selection of a survivable route of flight when everything is "in the green."

While low-level flying is a skill acquired rather easily by the experienced pilot, proficiency in *low-level navigation* is difficult to acquire and equally difficult to maintain. Reports from commanders in Europe and at home have indicated that Army aviators trained during the Vietnam era lack confidence and experience in low-level navigation. This is not surprising.

During the Vietnam era Southeast Asia has been the finishing school for the Army aviator. The U. S. Army Aviation School at Ft. Rucker, AL, graduates a student well versed in fundamentals. He has learned the specific skills and tactics needed to perform his unit mission "incountry," most often in combat. As the aviation units return home and the unit mission changes to meet a different threat, it will be necessary also to redirect the training of the Army aviator.

The need for increased emphasis on low-level flight is not being ignored among Army commanders. Tests of this doctrine in both Europe and the U.S. have isolated low-level navigation as the critical factor in mission accomplishment. Indeed the continuing development of aviation doctrine has sometimes been hampered by a shortage of proficient low-level pilots.

The transition from the airways to the treetops can be difficult for the individual aviator. Seeped in an attitude which equates altitude with safety—and proficiency with mastery of IFR flying procedures —he must accept a completely different set of values in order to train effectively for the mission he is to perform. If, however, he gains a proper appreciation of the threat these techniques are designed to counter, then the caution, precision and professionalism which characterized his earlier flying will serve him well in this new environment.

Low-level navigation in present day aircraft requires extensive preflight planning. A good rule of thumb suggests 2 hours of planning for a 1-hour flight. Terrain familiarization can reduce planning time somewhat, but this again var-

Even in the tactical environment Army aviators must shut down and wait for weather to clear

ies widely with individual pilots and area familiarity is most difficult to acquire if all operations are limited to low level. In a rapidly moving battlefield situation, quick response missions over unfamiliar terrain require some accurate means of position fixing.

During the Vietnam era development has been directed toward a sophisticated position-fixing system which will be common to both ground and air forces and which would tend to eliminate many of the control problems facing the combat commanders. In lieu of this expensive black box of the future, the present day aviator is left with map, compass and clock.

Some observers have pointed to simpler World War II vintage instruments which integrate air speed, direction and time data to produce accurate position information which can in turn be confirmed by pilotage. Such an interim solution would certainly increase our present low-level capability.

Low-light level TV viewing systems may soon enable seeing ground features and acquiring targets in complete darkness, and electronic station-keeping equipment may allow formation flying in low visibility but neither these systems nor terrain clearance radar is an appreciable help in navigation. All these developments point emphatically to the need for an increased degree of proficiency at low level.

On the training side of the ledger, training which once existed must be reestablished along with the encouragement of new training

Navigation in marginal weather can become even more difficult in the low level environment

innovations. In the early 1960s, the 11th Air Assault Division (T) departed from established aviation practices and began training for extensive airmobile operations at low level. At the same time there was a flurry of scientific research on factors affecting low-level flight. As tactics for the Vietnam conflict became established, interest waned in low-level techniques. Today, a significant increase in the ability to fly in the nap-of-the-earth is possible merely by redirecting energies toward this end rather than continuing to train for airline type flying in a peacetime environment.

Simple movies can put the student "in the cockpit," while stop action allows the instructor to point out the techniques and decisions which influence the "flight." Complex and expensive, but within the state-of-the-art, are low-level flight simulators with which the pilot could actually fly his mission in response to television or computer-developed imagery. Also within the realm of an engineering solution are certain cockpit environment factors which would boost mission success by decreasing pilot fatigue, or by simplifying the navigation and flying tasks required by current cockpit configurations.

Combat-readiness flying at minimum legal altitudes and without reference to radio navigation aids will reintroduce the pilot to some aspects of low-level navigation. Terrain features with some vertical development will begin to play a more important role in orientation. The pilot will begin to regain an appreciation for the systematic natural relationships between terrain and manmade objects and train himself to predict them and interpret their significance. The benefits of this technique are partial but not insignificant and might well be recommended to the "minimums only" aviator.

Human Resources Research Office (HUMRRO) scientists studying low-level navigation agree that optimum benefit in learning navigation skills can be obtained in flights at 50 to 100 feet above obstacles. Above this height the pilot acquires visual clues which are not available at treetop level. Below this height the likelihood of having an unpleasant experience with a solid object is increased while the navigation task remains about the same level of difficulty. Missions flown over approved routes at these altitudes provide maximum benefit for the aviator.

Familiarity with a particular area of operations can decrease mission planning time and cut mission response time. Techniques for teaching area familiarization systematically have been developed and have proven successful. It is not inconceivable that the "terrain briefing officer" will become an important part of each small aviation unit's operations section. His detailed, orderly presentation combined with individual study could result in measurable benefits in mission effectiveness.

Proficiency testing in low-level navigation is a possibility and it is not unlikely that the proven proficiency in this difficult art would prove more prestigious than proficiency in instrument procedures.

Clearly Army aviation can make significant strides in improving our low-level capability by intensive training with present techniques and equipment. More clear, however, is the fact that improvement beyond a certain acceptable level of accuracy is impossible short of the development of an adequate position-fixing device. We are entering an era when proficiency in low-level navigation alone will spell the difference between success and failure in helicopter operations and at least for the present the burden is squarely on the shoulders of the Army aviator.

In the mid-intensity environment a major role of Army aviation will continue to be movement of troops about the battlefield

A POINT OF VIEW

CW4 Robert Meade

In the new peacetime Army multiskilled aviators will be the ones who are retained. Senior warrant officers will be asked to excel in more than the cockpit. Some form of schooling, be it formal or informal, will be needed if they are to perform properly

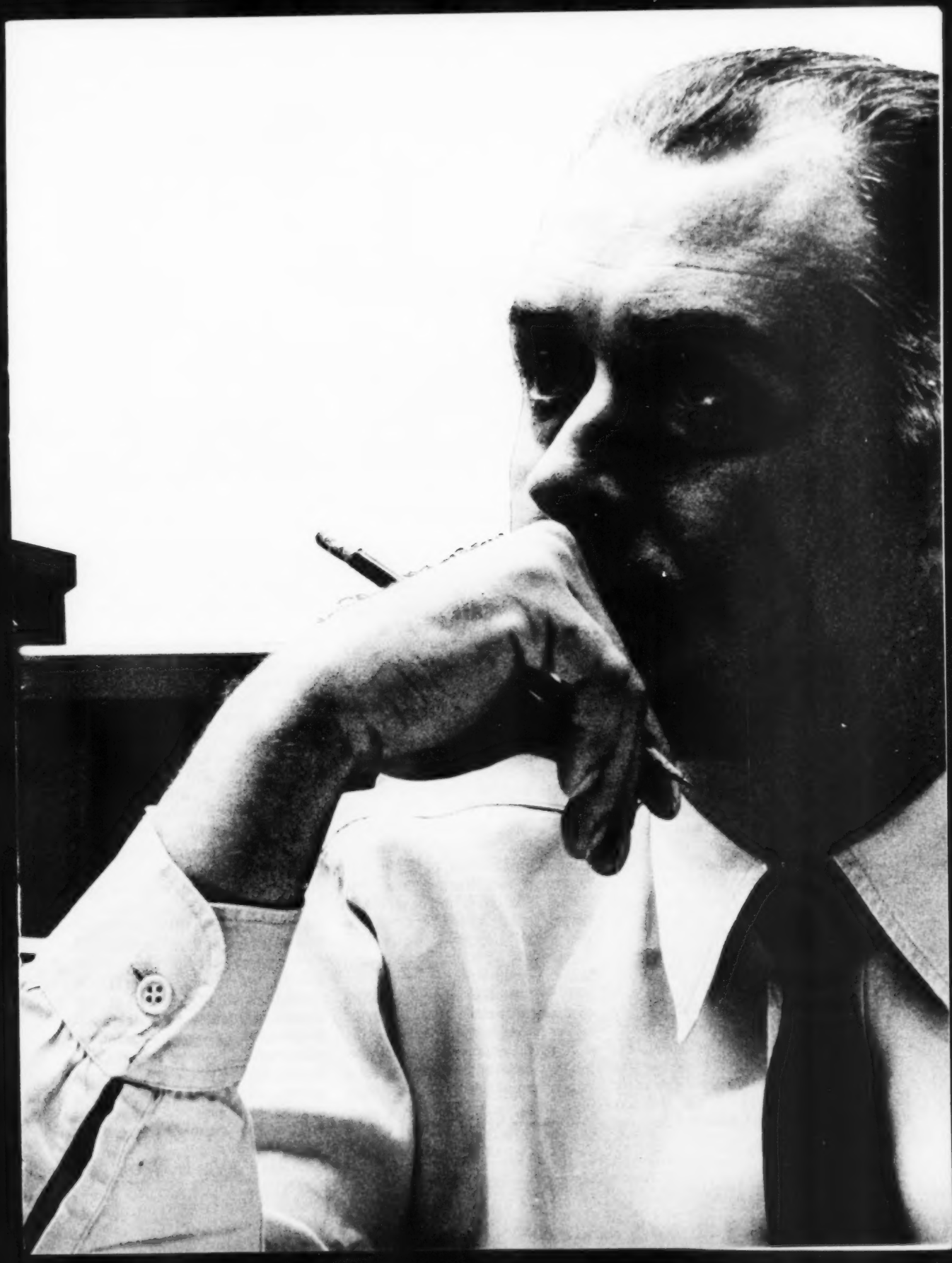
SINCE THEIR inception in 1969 the Aviation Warrant Officer Career Courses have been a subject of controversy within the warrant officer ranks. In some cases the threat of attendance alone has caused members of the corps to offer their resignations or ask to be retired.

As is too often the case with so many of us, we are quick to condemn and slow to commend. Unfortunately, the one to quickly condemn in this instance is offering himself as the sacrificial lamb rather than enhancing his chances should he be truly interested in making the Army his career.

With the prospects of a peacetime Army, TOE and TD assignments will be considerably reduced, and those who are retained to fill these slots will be selected on a most competitive basis. The individual with a well-rounded background, with skills in addition to those which relate directly to sitting in the cockpit, will be the obvious choice when the showdown comes. It is common knowledge that the days of the OJT administrative officer, supply officer, maintenance officer, etc., are gradually falling behind us and some form of school, be it formal or informal, is requisite to assuming many of these positions.

Though the 2 year college minimum education requirement for warrant officers has been waived in recent years, the current trend to assure that these levels are attained should be signal enough to alert even the most apathetic to the fact that multiskill training is not the vertex of the military career, but only the foundation. This is evident when one considers the mission assigned the warrant officer career course: ". . . to provide a basis for satisfactory performance in a wide variety of unit aviation-related functions and *a basis for future development for progression to technical staff positions.*"

Most aviation warrants are familiar with the first requirement of the school's mission—the training for unit aviation functions—but too many are either unaware of or



unconcerned with the second requirement—that of preparation for technical staff assignments. There is a measure of sympathy for these people since there is not nearly as great a demand for the staff trained aviation warrant officer as for the skilled "airline captain." But it is an undeniable fact that there is going to be an early shift to the former when the full impact of the peacetime environment befalls us and the multiskilled aviator will surely be the first in the breadline and the last to desert the battlefield. Exemplary performance in other than the cockpit is the mandate for the senior aviation warrant officer today and surely tomorrow.

In 1964 and 1965 several farsighted officers undertook to firmly establish a pattern of career development for the aviation warrant officer. The fact that the mission was undertaken during this extremely turbulent period in the aviation warrant officers' history made the task all the more monumental. At a time when it was difficult to keep up with the aviation warrant officers' whereabouts, these most perceptive individuals were formulating plans, soliciting ideas and lobbying for approval of a scheme designed to put the warrant on a tenable path in what had been a career pattern maze. This group aired such major topics of discussion as the CW5 and CW6, super grades, equilization of flight pay, bootstrap and other degree completion programs, and a means to recognize this breed of flying soldier who was so vividly distinguishing himself in Vietnam and other theaters of the world.

With time and a goodly amount of midnight oil these warrant officer program proponents—

• gained approval of several major innovations, the career course and advance civilian schooling;

• recognition in high places of the morale problem incidental to the inequities in flight pay;

• consideration of the so-called "super" grades.

Though the super grades are still under consideration, the fact that they were so strongly advocated by some of the early proponents of the career program has lent much impetus to their continued staffing at top levels.

One of the material benefits derived from the aforementioned efforts, and one which may eventually bring about the realization of those not yet attained, are the aviation warrant officer intermediate and advance career courses. The mission was given to the U. S. Army Aviation School at Ft. Rucker, AL, to develop a comprehensive course around a scope provided by Continental Army Command, Ft. Belvoir, VA. A small group of officers and warrant officers were selected to put the spirit of the dream on paper. They

Students must spend hours hitting the books, but in the long run their efforts will pay handsome dividends

were to give the Army an aviation warrant officer capable of rendering a "satisfactory performance in a wide variety of unit aviation related functions" and the basic necessities "for future development for progression to technical staff positions."

It was a large order, and the planning had to revolve around the commanders' needs and technical positions which the graduate would eventually be required to fill. Contrary to current thinking, the courses could not be designed around the warrant officers' expressed desires.

When the courses unfolded before the students, some found that it did in fact satisfy some of their needs and/or desires, but not all and the finished product did not entirely fill the combat commanders' needs either. It did fill gaps in many of the students' military backgrounds, refresh their memories on a variety of subjects, and provide a foundation upon which to pursue other future endeavors.

As is the case in most forms of schooling, there had to be a few fastidious individuals who outwardly proclaimed dissatisfaction and/or disappointment with the course. Some have proven to be eloquent in their condemnation, verbose in a crowd but lacking at course critique time. Unfortunately, the mundane appeared content and did not voice either approval or constructive criticism in the right places. As a result, and much to the chagrin of their successors, some excellent and very relevant suggestions have too often been heard by only the wife or bartender.

Most of the criticism in the first few classes (both in and out of the classrooms) centered around a valid point—the experience level of those in the class. With the advance course proudly announcing an average time in service of over 20 years, what subject material, if any, was not already common knowledge among them? Too, the intermediate course had those senior W3s with many years service and possessed a generous knowledge of the subject material. This also was evident to the instructors who gained a wealth of information from the students, and put it to good use in subsequent classes.

It should have been obvious to these early students that in the near future the old bold warrant officer ranks would possess *only* graduates of the course, and future classes would consist of much younger, less experienced aviation warrant officers. Most of these newer individuals would be aviators spawned in the Republic of Vietnam, nursed on C-rations in a sandbag pilots' lounge, and matured with cyclic, throttle and trigger. Their assignments were "short-tour" even in the U. S. and few were seen to be without suitcase in hand when not in Vietnam. Because they missed that charm period the older warrants enjoyed before mid-1961, unforgiveably few were fortunate enough to learn a career-enhancing, aviation-related skill or trade.

There are probably still quite a few warrants who haven't had the time to sit down and decide where they would like to go in the aviation field over and above being a throttle jockey. Many would probably prefer straight flying assignments—an admirable thought but not in keeping with the goal of the Army. Thus, some form of education must be ever present to "force feed" experience that has not been available for 10 years. There is a solution: a career course designed to place individuals somewhere along that vertical network of career progression and allow them to catch up. This is not to say that they are behind, for in their deeds alone they have shown that they have no peer. Rather, it emphasizes that knowledge gained in additional fields would surely enhance their futures in an already chosen field of aviation.

It is up to those of us who are now or have been students in the course to offer suggestions based on sound reasoning and mature judgment with a view to making it serve its designed purpose. It is apparent that unwarranted criticism rather than solid recommendations by so few representative of so many is premature. The critical eye in a farsighted head could do much to enrich a program designed to teach those who do not yet know.

Charlie and Danny's Write-In

Dear Charlie and Danny: What is the proper rpm setting on U–8 aircraft for checking the operation of the deicing system prior to takeoff? Understanding that the vacuum pressure is "in the green," would any harm be done if the check were performed at 1500 rpm as the –10/4, –10/5, –CL/4 and –CL/5 indicates or at 2000 rpm as indicated in the dash 20 and the USAAVNS Maneuver Guide? Reading "between the lines" of the above questions you can see that I am in effect asking for a reading on the order of precedence of those publications to be used in settling any other discrepancies.

LTC C. A. S.

Danny's answer: The rpm setting for checking the operation of the deicing system on the U-8D and U-8F has been changed to 2600 following a manual review conference in August of last year. The new rpm requirement will be noted in both the dash 10 and dash 20. Many times power settings, prop rpm's, etc., will be different in the dash 10 and dash 20, but remember the personnel making these checks may be looking for different results. Generally runup procedures noted in the dash 20 are for diagnostic purposes to pinpoint specific faults, whereas the pilot using the –10/CL is checking for normal operation of a system. It was determined that a more accurate check of the deicing system could be made using 2600 rpm and, in addition, the pumps would be cooled more adequately due to the higher volume of air passing through them.

Your continued interest in and submission of questions to Charlie and Danny is solicited and appreciated. If we can be of further assistance please advise.

★ ★ ★

Dear Charlie and Danny: I would like to call your attention to an error concerning gross weight of the U–21A that I have noted in either the dash 10 or dash 20. Gross weights throughout TM 55–1510–209–10/1 are given as 9,650 pounds while in TM 55–1510–209–20/1 on page 1-14 the gross weight is given as 9,715 pounds. Recommend that the differences in the weights be investigated and the new or corrected weights be given to the troops in a future change.

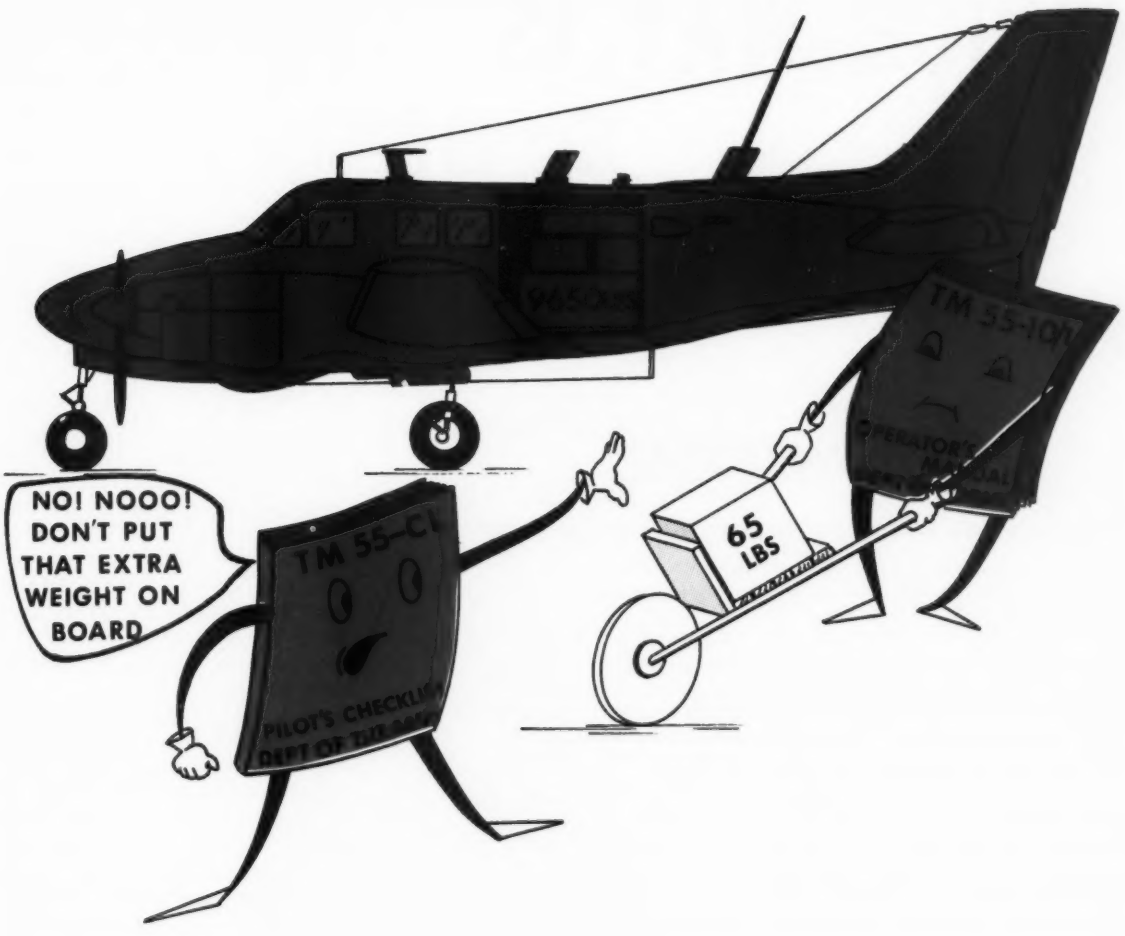
SFC W. W. W.

Danny's answer: Your letter was most timely. The mistake that attracted your eagle eye is in the dash 20, not the dash 10, and came to us at just the right time to be included in a manual change that was going to press. In the future the dash 20 should reflect the correct weight of 9,650 pounds. Your continued interest and assistance in pointing out these mistakes in our publications are solicited.

★ ★ ★

Dear Danny: A recent study of the dash 10 of the UH–1C/M has revealed some foggy areas I thought you might be able to clear up. The first concerns the procedure for obtaining maximum glide distance. One answer is to use 84 knots air speed and a rotor rpm of 295. On the next page, however, figure 4-2 gives 105 knots indicated air speed (IAS) and 324 rotor rpm. Are both correct or is there an error in one of the answers? The other question has to do with the emergency procedure for loss of both hydraulic systems. The procedure discusses the deterioration of the "lock and load" control system. I assume that it is referring to the cyclic accumulator but I am not positive. Could you please enlighten me on this subject and give a detailed explanation of the reasons behind the deterioration?

CPT S. W. H. Jr.



Danny's answer: In answer to your first question, TM 55-1520-220-10 is confusing in the area referenced. The following change has been submitted to clarify the information (if you will follow in your dash 10 it will be easier). In chapter 4, page 4-4, delete paragraphs 4-14, 4-15, 4-16, 4-17. On page 4-5, delete figure 4-2 and the note alongside. Add the following new paragraph:

4-14 MAXIMUM GLIDE AND MININUM RATE OF DESCENT.

4-15 Air speed for minimum rate of descent in coordinated steady state autorotation in the UH-1C/M is 50 to 63 KTAS, regardless of rotor speed, density altitude or gross weight.

4-16 Air speed for maximum glide distance incoordinated steady state autorotation in the UH-1C/M varies from 87 KTAS at low gross weight (6,700 pounds) to 102 KTAS at high gross weight (8,800), regardless of density altitude.

4-17 In general a good compromise between maximum glide and minimum rate of descent is 70 knots and rotor speed in midgreen (310 rpm).

In answer to your second question, the lock and load does refer to the cylinder assembly accumulator. The gradual deterioration is due to a small amount of fluid under high pressure leaking past the seals and reducing the internal pressure.

Thanks for the questions and thanks to U. S. Army Aviation Systems Command engineering for helping with the answer.

WHICH WAY IS UP

Aeromedic

Provided by the Society of U. S. Army Flight Surgeons

Major Bennett G. Owens Jr., M.D.

INCREASED NIGHT and weather flying in Army aviation adds to your chances of encountering vertigo. The trouble is that the encounter is likely to be fatal if you do not know what you are doing. Don't be too quick to tune out this message. You may have been flying before most flight surgeons started shaving and you may never have encountered vertigo. But it does not follow that you *can't get vertigo* and to read further is a waste of your time. The only answer to this type of reasoning is that your flight surgeon would like to meet you. If he can prove that you don't get vertigo, the two of you can make medical history. Vertigo occurs because of the way the human body is put together. If yours is different you aren't human but you are of considerable interest to the medical profession.

If you fly, vertigo sooner or later is going to slip up on you and zap you between the eyes (unless you stick to only "field grade" weather). If you know when to expect vertigo, what it can do to you and how to prevent or overcome it, you have a good chance of coming back with a good story to impress everyone with your aerial know-how. If you don't you will probably join the evergrowing number of aviators who had interesting experiences but never had a chance to relate them.

The best way to learn how to cope with vertigo is to learn what it is and what it does, and then get some actual experience under controlled conditions. This will give you the personal knowledge you need to keep from killing yourself when you encounter it under operational conditions. This article—plus the next two "Aeromedic" articles appearing in future issues of the DIGEST—presents facts about vertigo and suggests some ways you can obtain experience with it with a minimum of danger.

The best place to start a discussion of vertigo is with *what is it?* The problem is that there are two different problems called vertigo. When a doctor says vertigo he is talking about a specific medical problem—a sensation of spinning or whirling caused by a disease or

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The best way to learn how to cope with vertigo is to learn what it is and what it does, and then get some actual experience under controlled conditions. This will give you the personal knowledge you need to keep from killing yourself when you encounter it under operational conditions. This article—plus the next two "Aeromedic" articles appearing in future issues of the DIGEST—presents facts about vertigo and suggests some ways you can obtain experience with it with a minimum of danger.

The best place to start a discussion of vertigo is with *what is it?* The problem is that there are two different problems called vertigo. When a doctor says vertigo he is talking about a specific medical problem—a sensation of spinning or whirling caused by a disease or

injury of the inner ear. This kind of vertigo is pretty upsetting both to the patient who has it and to the doctor. The patient is upset because he usually can't walk or even stand up due to a spinning sensation he feels; the doctor is upset because he has a tough job finding out exactly what is wrong with the inner ear and an even tougher one deciding what to do about it. Obviously, a person with this kind of vertigo can't fly.

When an aviator talks about vertigo he means something completely different. He is referring to a condition in which a person is not sure of his position in space relative to the ground. To put it simply, he doesn't know which way is up (or down). It happens because his sense of balance was designed to operate on the ground and plays tricks in the air. This kind of vertigo is perfectly normal and is not caused by disease or injury. It makes flying a little difficult while present but usually lasts a short time and has no effect on your flight status (unless it causes you to crash and break something). Both aviators and nonflying doctors know what they are talking about, but the flight surgeon is not so lucky. He knows about both kinds of vertigo and in discussions with others he might become confused. To keep this from happening the term *spatial disorientation* has been developed to replace *pilot vertigo*. This term describes what is actually going on and eliminates confusion. Since the confusion could possibly hit you where it hurts (in the hip pocket) you should use the more accurate term. It will be used in the rest of these articles.

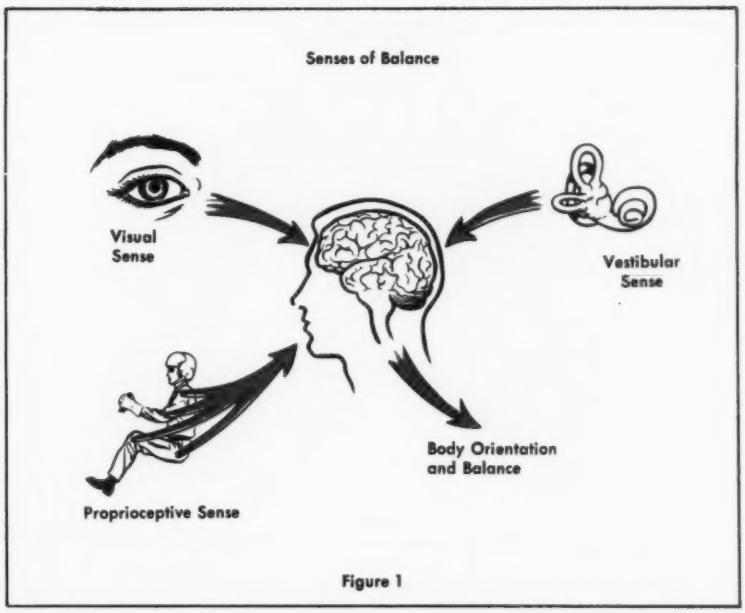


Figure 1

The second thing you need to know about spatial disorientation is what causes it? We have already said that it is brought on by a malfunction of your sense of balance, but to understand how it happens you have to understand how your sense of balance works on the ground.

Under normal conditions (on the ground) there are three senses that help you keep your balance. They are the *vestibular sense*, the *proprioceptive sense* and the *visual sense*. Signals from all three are

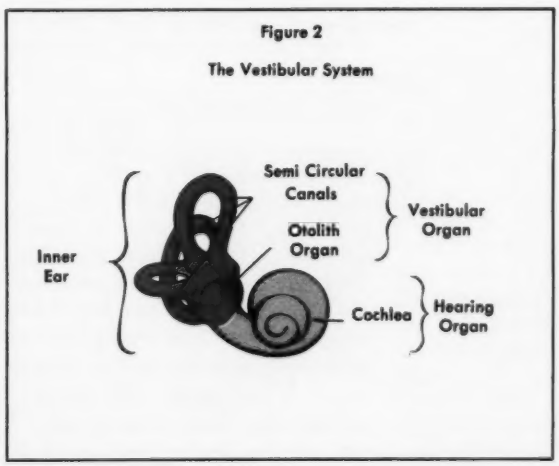


Figure 2

The Vestibular System

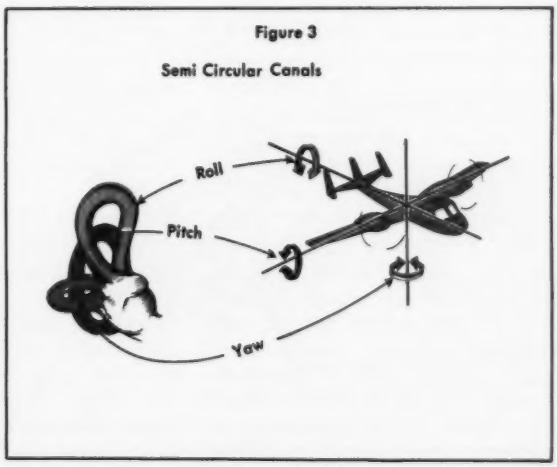


Figure 3

Semi Circular Canals

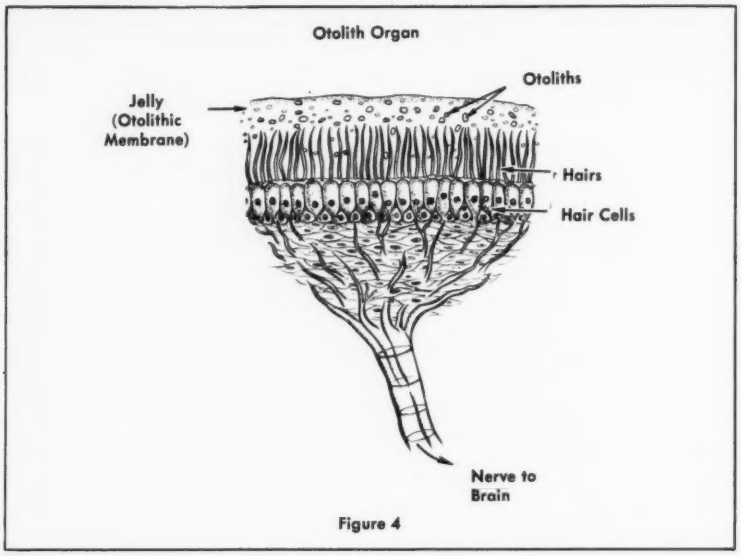
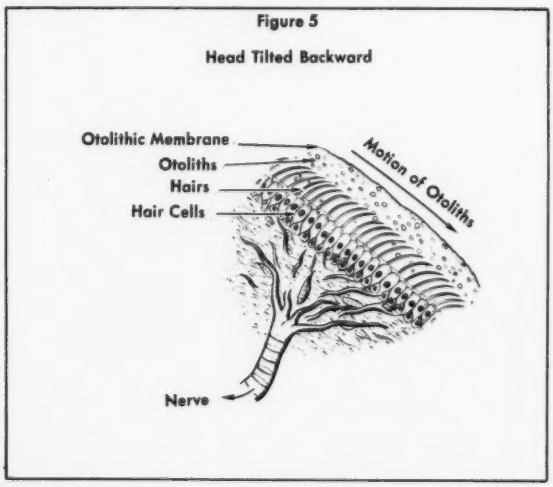


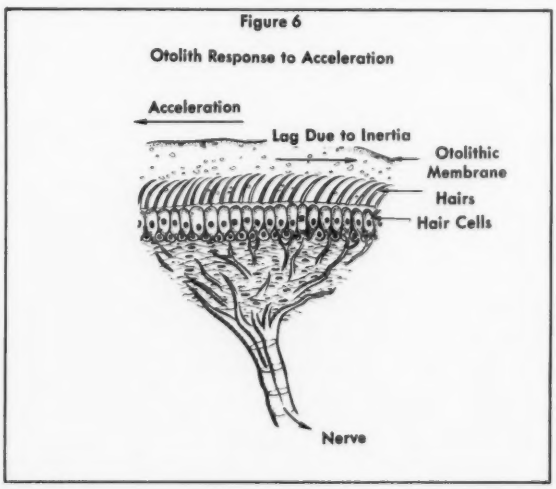
Figure 4

sent to the brain which combines them and tells you your body's position (figure 1).

The vestibular signals originate in the *vestibular apparatus* located in the inner ear. Each vestibular apparatus has two major components—the semicircular canals and the otolith organ (figure 2). There are three semicircular canals located at 90 degree angles to each other (figure 3) so that there is a canal in each axis of motion (pitch, roll and yaw). They are used to detect rotation. These canals are hollow tubes in the bone of the skull and are filled with a fluid called *endolymph*. When the head is rotated the endolymph lags behind the walls of the canal causing relative movement. You can demonstrate this by rotating a glass filled with ice and a liquid on top of a table. As you start to spin the glass the ice and the drink move more slowly at first because of inertia. Thus, you have relative motion of the liquid with respect to the walls of the glass. The same thing happens in the semicircular canals. Inside the canals there are tiny hairs which stick up into the endolymph. The relative movement of the endolymph causes the hairs to bend. This produces the signal which is sent to the brain where it is received and interpreted as rotation.

The semicircular canals have two major limitations which can cause trouble in flying. The first is that it takes a certain strength and rate of rotation to bend the hairs. Therefore, motion which is of very short duration or very slow may not be detected. The second limitation is that when the speed of rotation is constant for a long enough period the endolymph will catch up with the walls of the canals and the relative motion will cease (you can get another drink and demonstrate this also). When the relative motion ceases the tiny hairs return to their resting positions and the signals going to the brain indicate that no rotation is taking place. If the actual movement then stops the canals will stop but the fluid will keep moving a little longer, again because of inertia. This causes the hairs to bend in the opposite direction from the movement and the brain will be told that you are ro-





tating in the opposite direction when you are actually just slowing down.

These limitations in the design of the semicircular canals may cause you to misinterpret what is actually happening to you. You may feel that you are not moving when you really are, or you may feel that you are turning instead of slowing down. This misinterpretation of what is actually happening is called an *illusion*. It is the illusion or misinterpretation of the actual situation that confuses you about your position in space and leads to spatial disorientation.

The other part of the vestibular system is located where the semicircular canals come together. It is made up of a little blob of jelly-like material with tiny pieces of calcium carbonate (sand) imbedded in it and another set of tiny hairs which stick up into the jelly (figure 4). This organ takes its name from these sand particles and is called the otolith (ear stone) organ. It is used to detect tilting movements (linear) of the head. When the head is tilted the acceleration of gravity causes the otoliths and the jelly to tend to slide in the direction of the tilt. For example, when you tilt your head backward the blob of jelly with the particles in it tends to slide backward. This tilts the hairs backward and sends a signal to the brain where it is interpreted as a tilt backward (figure 5).

The otolith organs also have a serious design defect. The otolith can be moved by G-forces as well as by head tilt. For example, if you accelerate forward inertia will cause the otolith to lag behind the rest of the inner ear. This will bend the hairs the same as a tilt backward and you will think that you are tilting over backward when you are actually accelerating forward in a straight line (figure 6).

The second sense you use in keeping your balance on the ground is the *proprioceptive sense*. This is also known as the kinesthetic or "seat-of-the-pants" sense. It is made up of large numbers of tiny sensors located all through the body and the nerves which connect them to the brain (figure 7). The proprioceptive system does two things.

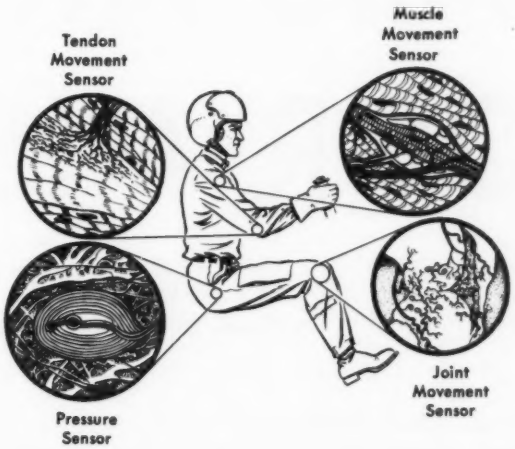


Figure 7

First, it tells you where the parts of your body are at all times. Whenever you move a part of your body it triggers the sensors located in the muscles, joints and tendons and causes signals to be sent to the brain telling you what movement is being made. This is what allows you to touch your nose with your finger even with your eyes shut (if you can't you had better quit now and see a doctor).

Second, whenever a part of your body is in contact with a solid object, such as the ground or a chair, the pressure sensors in that part of the body are stimulated and signals are transmitted to the brain telling you what part of your body is carrying the weight. Since the weight is always directed downward (toward the ground) this tells you which way is down. The major problem with the proprioceptive system is that it can't tell the difference between gravity and G-forces so that acceleration can produce a false sensation of down.

The third sense used in keeping your balance is your eyes or the *visual sense*. By looking at things around you, you can tell which way is down. This sense is the *most important* to you as an aviator because it is less likely to give you problems in flight than the other two are and its signals are usually able to override those coming from the other senses. This is how your sense of balance works on the ground. As you have seen, the senses which contribute to your sense of balance have some built-in limitations which can cause trouble when you get into the air. Next month the second article in this series will discuss the specific problems caused by the limitations in the vestibular and proprioceptive senses and what to do about them. A third article will discuss some of the limitations of the visual sense and how to handle them.

PASS AROUND YOUR MISTAKES

Lieutenant Commander Jeffrey D. Hartman

We learn quite well from our mistakes . . . the bigger the error the greater the impression. What about the mistakes made by others? If we could accept as fact—and reality of the past—the revelations of others, our store of knowledge could be such that there might be a marked reduction in hairy experiences, wrecked aircraft and loss of lives among flying personnel . . . the following account is true . . .

WARRANT OFFICER Reaves' article ["The Freedom Bird"] on his engine failure in the November AVIATION DIGEST reaffirmed my resolve to pass along some of my own mistakes in an engine-out I had in the fall of 1970.

I was an instructor pilot (IP) on assignment with the Navy at Ellyson Field at Pensacola, FL. I had been instructing for some 34 months and had about 2,000 instructional hours, the majority in the UH–1D and TH–1L models. There were four of us in my TH–1L that day: a Navy chief petty officer crew chief, a flight student from another field along for the flight time, myself and my student who was only about 10 hops away from his own wings. (I kidded this student when he graduated that he had his own black cloud because subsequent to this engine failure we had two separate hydraulic failures and a UHF transmitter failure on an IFR cross country. Despite the kidding he was one student that I was proud of.)

On this particular hop we were filed IFR from Ellyson Field into Troy (AL) Muni for some GCAs. It was a beautiful morning at 3,000 feet and we were 5 miles west of the Troy radio beacon making final arrangements for our handoff from Cairns Army Airfield approach control at Ft. Rucker, AL, to the Troy controller. Without any prior indications there was a muffled thump and the nose kicked left slightly.

At first I thought my student, who had the controls, had slipped off one of the rudder pedals. However, when I looked his way he also was looking at me and I concluded that this wasn't the answer. Taking the controls there wasn't much to do as the student had instinctively put the bird into an auto. All those throttle chops during training paid off.

I next checked the engine gauges. The first thing I saw was the EGT pegged at 980 degrees C. and the Ng slowly winding down. This ruled out the possibility of a fuel control malfunction as with that temp it was obvious that the engine was getting plenty of gas. This indicated to me that the problem lay with the turbine innards and I subsequently ruled out an attempt for an air restart.

This analysis still sticks in my mind as one area where I owe someone else for making the mistakes for me. There had been one of the other HT–8 instructors who had had an engine-out warning system malfunction in a TH–57 and had whipped into a local golf course in an auto only to find out that he still had a perfectly good engine after everything was over. This blooper had been hashed over in the ready room and was the first thing that came to my mind. While the engine analysis didn't bail me out of the situation, it helped to put things in order in my own mind which is the definition of how

to handle any emergency. To this long forgotten fellow driver—thanks.

So far so good, but I next made two mistakes. The first was an error of omission. I didn't secure the engine. I'd never secured an engine in flight before and I didn't do it then. It just never occurred to me. So all the way down we had our own little barbecue going in the combustion chamber. Luckily the fire got no further.

The second mistake sounded like a good idea at the time. I turned into the wind line which was about 110 degrees to my left and then looked for a landing spot straight ahead. This was instinct. The procedures for an engine failure in the Navy IFR helo syllabus is to enter an auto then turn to the last known wind. This is great provided this is all the information you have and assuming you're in IFR conditions. We, however, were in VFR conditions but I did what I had always done with practice IFR autos—I turned to the wind.

The problem with selecting a landing site straight ahead is that it is very difficult to judge how far the bird will glide straight ahead. The wind velocity can make all the difference in the world as to how far you travel over the ground. If the occasion arises again I will first check for a field off to either side of the helo and then shoot to enter a 180 degree position at a familiar altitude for a 180 auto. Doing this you're on familiar ground and any miscalculation in altitude can be adjusted for with entry turns; not so with a straight-in auto.

The situation developed so that we were going through about 2,000 feet and I was rolling out into the wind line that was passed to us from Cairns approach for the Troy area. I told my student to go to "guard" so I could acquaint the world with our situation; enters third mistake.

I, and apparently all of this particular student's previous instructors, had not pointed out the "guard" transmit position for the UHF control box. Consequently, he saw the receiver switch on T/R+G and said, "You're on guard, sir." So we went out over the air thinking "guard" but still on Cairn's frequency. No big deal in this case because Cairns got the message and had us on radar. In some less hospitable environment where pickup time is of the essence it could make a lot of difference. Moral? Brief your copilot about cockpit duties in the case of an emergency.

Now, here's how my straight-in auto caught up to me. We hit my selected field too high to make the field continuing straight but too low for a 360 degree turn. I'm sure that Army aviators know the Alabama terrain; lots of trees all snuggled up to a few cleared fields. Again I was lucky; field number two was straight ahead but just a tad on the long side. I consequently had to start my flare a little on the high side and a little more gradually than I would have preferred in order to clear the trees.

The last tree went by just as my alternatives ran out and I leveled the bird around 50 feet with zero ground speed and nothing to do but enjoy the ride. I personally would like to thank Bell Helicopter Company for putting all that inertia in their rotor heads because the only damage to the bird from my 50 foot throttle chop was a sheared crosstube and a lot of dust. Finally, sitting on the deck, I realized that the throttle, fuel, etc., were in the wrong positions and corrected the situation after the fact.

The rest of the story deals mainly with the excellent service we got from the Army. There was a UH–1 from Ft. Rucker in the area with members of an accident investigation team onboard looking for parts of an OH–13 tail rotor lost in flight earlier in the week. They arrived on the scene shortly after we did, complete with a photographer, plane guards and even a flight safety officer.

I was lucky. Some of the mistakes I had to make myself, at least one was made before me and I didn't have to repeat it. It was a valuable lesson for me. Someone once said something like this: Experience is the best teacher and man learns by no other. I think flight safety is learning from others' mistakes; I hope you've learned something from mine.

The "guard" transmit and receive position for the AN/ARC-51 BX is clearly seen on the lower left . . . the T/R+G *(guard receive only)* select position is on far right

EXTRACTION

WITHOUT A LANDING ZONE

Captain Carleton P. Vencill

Training in the use of the rescue systems discussed here would be of value. Aside from fabrication of the items that may be employed, instruction and practice in tying the basic knots is indispensable to assure security of the system and safety to the evacuee. Availability of nylon climbing rope alone does not mean that a safe extraction can be made. Lack of either experience or knowledge in the proper use of these systems might contribute to disaster

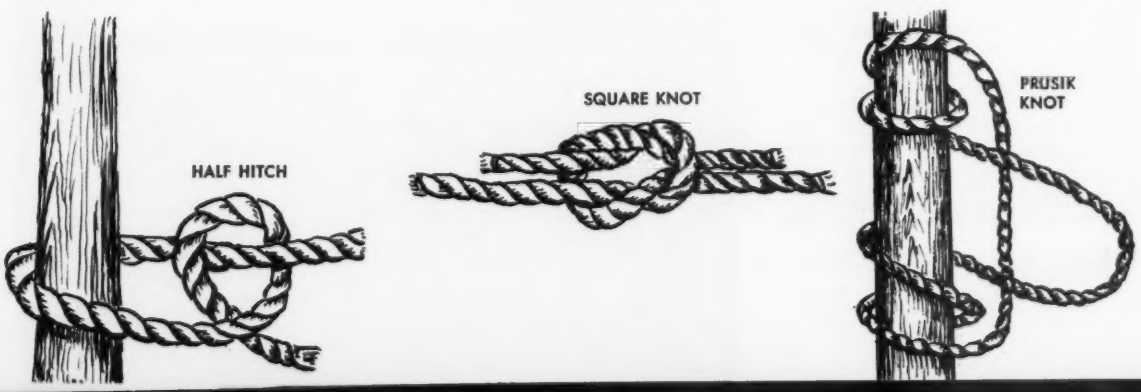
YOU ARE A Ranger company commander and one of your 6-man teams reports that it is in contact with an unknown sized enemy force and is moving to an extraction landing zone. The Ranger team advises that it has one dead and one wounded; it is surrounded and unable to move to an extraction landing zone. How will you get them out?

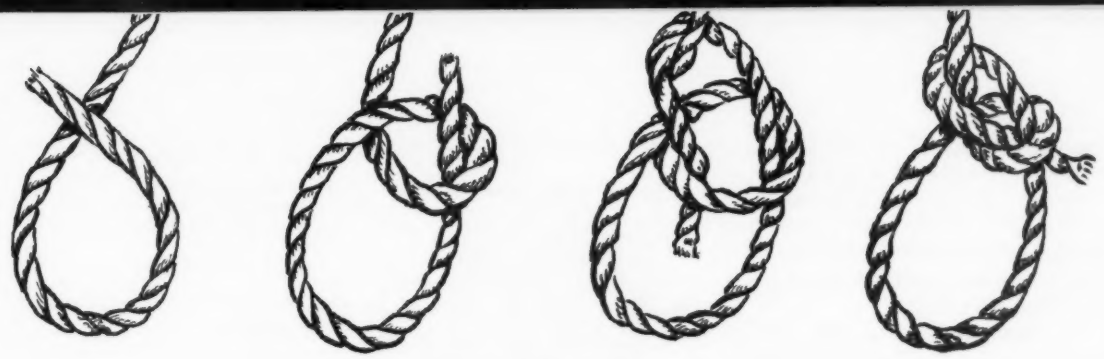
You are the commander of an aviation unit. One of your helicopters has been downed by enemy ground fire and the copilot and a gunner have been injured. The closest landing zone is 1,500 meters away and there are no friendly troops in the immediate area. How will you extract them?

You are the commander of an Infantry battalion and one of your units is in contact. The unit has reported that it has three wounded men who need an emergency "Dustoff." The closest landing zone is 2,000 meters away and there are no Dustoff aircraft with operational jungle penetrators. You have been ordered by the brigade commander to maintain contact with the enemy. How will you evacuate your wounded personnel?

Problems like these are encountered every day in the Republic of Vietnam. Some commanders do not solve them until it is too late; however, for those who are familiar with the emergency extraction equipment available the problem is solved with a minimum loss of time and personnel.

How will you extract someone from the jungle floor if a jungle penetrator is not available? A rope





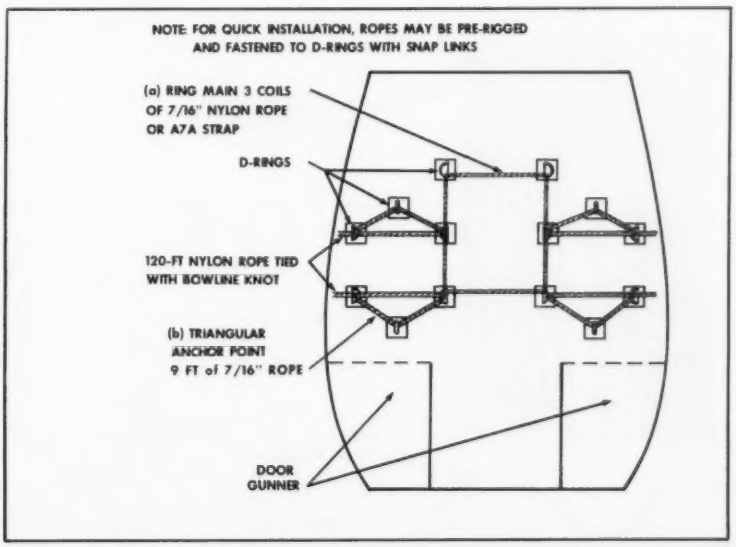
BOWLINE KNOT SEQUENCE

ladder may be your answer *if* it is long enough and *if* the person is not injured. But, what can you do if you do not have a rope ladder, or if the man is wounded? You can get him out with a little knowledge and a 120-foot nylon rope. This article will explain the equipment and techniques you need to construct emergency extraction equipment.

The nylon climbing rope is the rope most commonly used for emergency extractions. This rope comes in coils of 120 feet and is $\frac{7}{16}$ inch in diameter. When new it has a breaking strength of approximately 3,600 pounds. Its great elasticity is valuable as a safety factor. Unlike cotton and hemp ropes which will break when great tension is applied, the nylon rope will stretch approximately ⅓ of its original length before breaking.

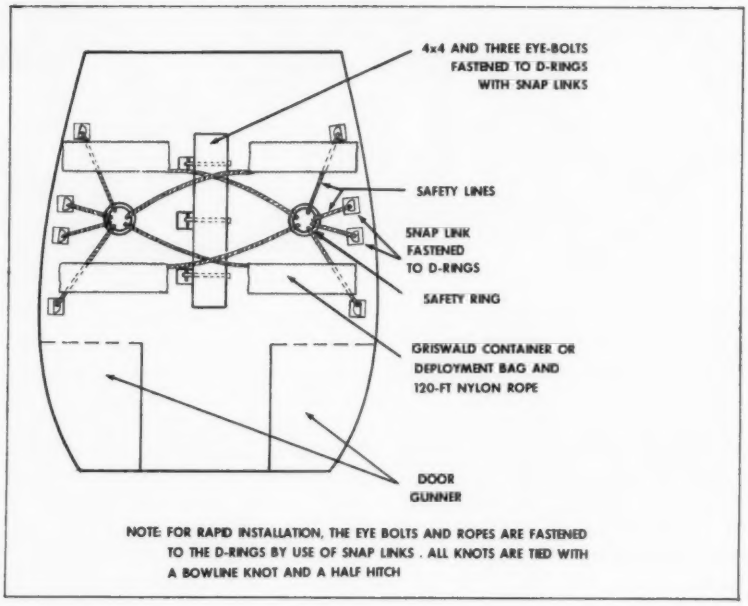
The terms you will encounter in rope work with extraction equipment are: half hitch, running end and standing end of the rope. The knots most frequently used are: square knot, bowline knot and the Prusik knot (see illustrations, pages 18 and 19). The running end of the rope is the end which can be used. The standing end of the rope is the fastened end. A square knot is used to tie the ends of two ropes of equal diameters together. It should always be secured by a half hitch on each side of the knot. The square knot will not slip and will draw tight under strain. A bowline knot may be used on the end of a rope or on the center of the rope. The bowline is always half hitched after the knot is tied. It may be used for both tying in on climbing ropes and as a piton anchor. The Prusik knot is very similar to the lark's head or ring hitch commonly used to attach baggage tags. The difference is that the Prusik knot is wound around the anchor point twice. This knot may be used to anchor a fixed rope to various anchor points. It is tied with a bight of rope or with an end of rope. If tied with ends of rope, a square knot is used to complete the Prusik knot.

Extraction rigs are secured by using the D-rings on the floor of the helicopter. These rigs may be fastened with several short lengths of rope, or you can connect a main anchor point and four safety lines to the D-rings on the floor of the helicopter. Whichever method or combination of methods you choose you should remember that good tiedowns must be safe and easily rigged and derigged. Extraction rigs can sometimes be so complex it could take in excess of 30 minutes to rig and derig a helicopter. This can cause complications if the extraction helicopter is grounded by mechanical problems at the same time an emergency situation arises. An additional aircraft may be obtained, but do you have an


NOTE: FOR QUICK INSTALLATION, ROPES MAY BE PRE-RIGGED AND FASTENED TO D-RINGS WITH SNAP LINKS
(a) RING MAIN 3 COILS OF 7/16" NYLON ROPE OR A7A STRAP
D-RINGS
120-FT NYLON ROPE TIED WITH BOWLINE KNOT
(b) TRIANGULAR ANCHOR POINT 9 FT of 7/16" ROPE
DOOR GUNNER

The First Method for internally tying down rescue rigs using short lengths of nylon rope

A Second Method for internally tying down the extraction rigs using a 4 x 4 with three eye bolts and nylon rope

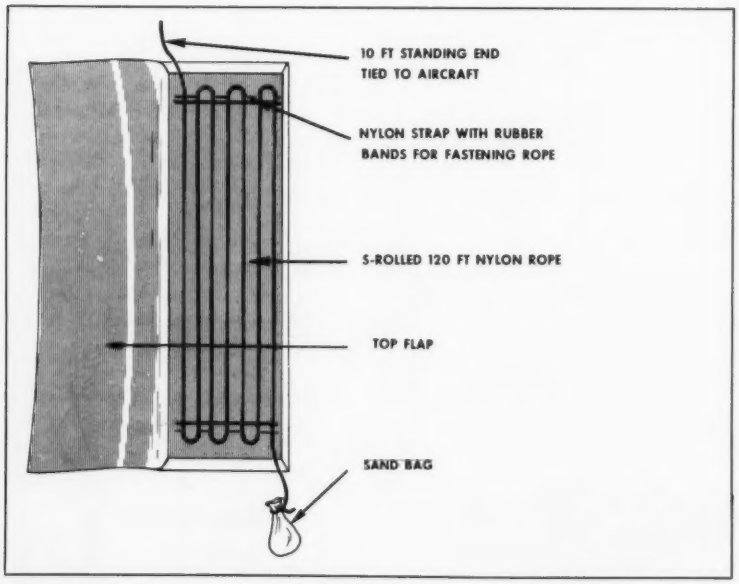

4x4 AND THREE EYE-BOLTS FASTENED TO D-RINGS WITH SNAP LINKS
SAFETY LINES
SNAP LINK FASTENED TO D-RINGS
SAFETY RING
GRISWALD CONTAINER OR DEPLOYMENT BAG AND 120-FT NYLON ROPE
DOOR GUNNER

NOTE: FOR RAPID INSTALLATION, THE EYE BOLTS AND ROPES ARE FASTENED TO THE D-RINGS BY USE OF SNAP LINKS . ALL KNOTS ARE TIED WITH A BOWLINE KNOT AND A HALF HITCH

additional extraction rig and is it simple enough to install enroute to the extraction point?

As mentioned, there are two methods of internally tying down extraction rigs. The first you may use is with several short lengths of rope. The initial step is to form a ring main (see a, First Method) by interlacing three coils of $\frac{7}{16}$-inch nylon rope or an A7A strap with the six center D-rings on the floor of the helicopter. The second step is to interlace four 9-foot lengths of $\frac{7}{16}$-inch nylon rope between three additional D-rings on the floor of the helicopter to form a triangle (see b, First Method). The last step is to tie the 120-foot nylon rope with a bowline knot to the triangular anchor point. For quick installation prerig the ropes and fasten them to the D-rings with snap links.

The other method of internally tying down extraction equipment is with a wooden 4 x 4, three eye bolts, four 120-foot nylon ropes and a safety ring constructed from ½-inch iron rod (illustration, Second Method). First, drill three holes through the 4 x 4, then bolt on the eye bolts and fasten them to the helicopter floor with snap links. Bowline knots tie the standing ends of four 120-foot nylon ropes on opposite sides of each other to the 4 x 4 and then to the safety ring.

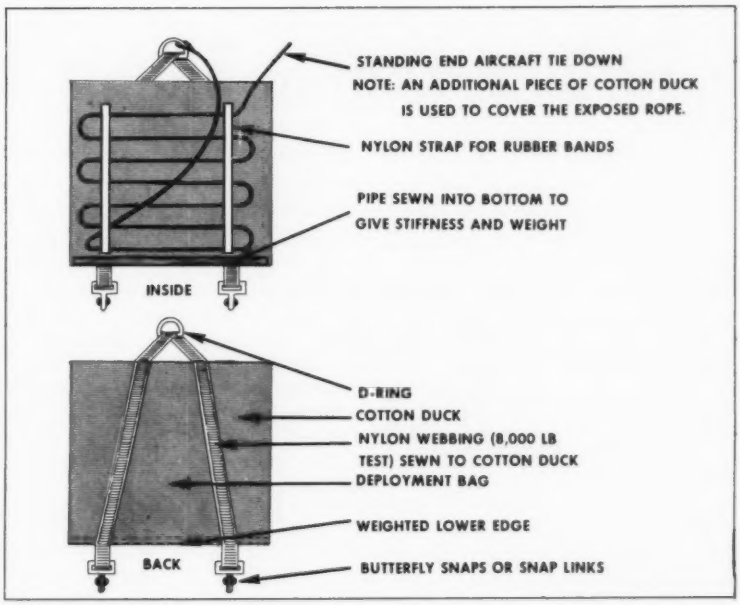

10 FT STANDING END TIED TO AIRCRAFT
NYLON STRAP WITH RUBBER BANDS FOR FASTENING ROPE
S-ROLLED 120 FT NYLON ROPE
TOP FLAP
SAND BAG

The two safety rings each have four additional safety lines which are fastened with snap links or butterfly snaps to the outer D-rings on the floor of the helicopter. You construct safety lines of $\frac{7}{16}$-inch nylon rope or 2-inch nylon webbing cut to the desired lengths.

Since the 120-foot nylon rope is a life line to the evacuee, it deserves a great deal of care in storing. There are two methods available to you: the modified Griswald container and the deployment bag. The most frequently employed method is the modified Griswald container. This container is also used by Airborne troops when jumping with the M–14 rifle. Slight modifications are needed when employing the Griswald container for storing and deploying the 120-foot nylon rope. Two nylon straps with loops for rubber bands must first be sewn on the inside of the container. Sew each nylon strap 6 inches from the top and bottom of

The Griswald container is the most frequently used means of storing and deploying the nylon rope and extraction rig

The deployment bag is only used with the Stabo rigs. The exposed standing end of nylon rope should be protected with cotton duck


STANDING END AIRCRAFT TIE DOWN
NOTE: AN ADDITIONAL PIECE OF COTTON DUCK IS USED TO COVER THE EXPOSED ROPE.
NYLON STRAP FOR RUBBER BANDS
PIPE SEWN INTO BOTTOM TO GIVE STIFFNESS AND WEIGHT
INSIDE
D-RING
COTTON DUCK
NYLON WEBBING (8,000 LB TEST) SEWN TO COTTON DUCK
DEPLOYMENT BAG
WEIGHTED LOWER EDGE
BACK
BUTTERFLY SNAPS OR SNAP LINKS

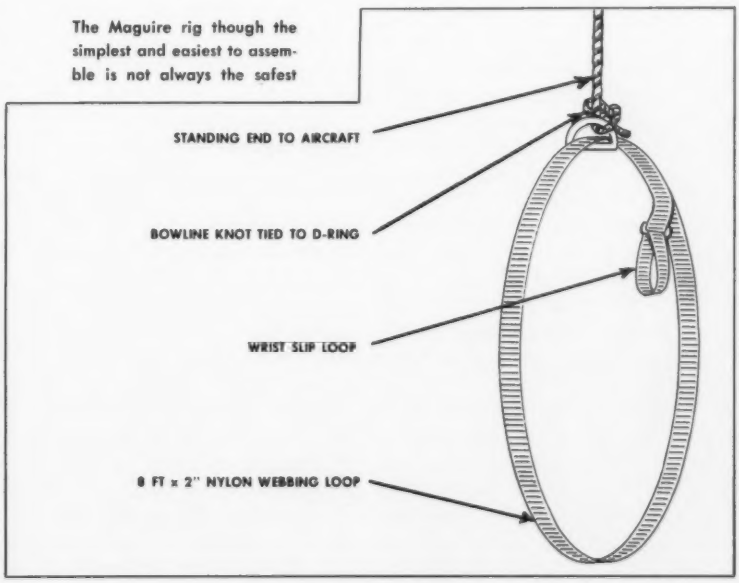
the container. Then, S-roll the 120-foot nylon rope inside the container and fasten with rubber bands. This ensures that the rope is evenly rolled and does not become entangled during deployment. Leave out a 10-foot standing end on one end of the container for tying to the inside of the helicopter and a 4-foot running end on the other end of the container. You should weight (sandbag) the running end of the rope so as to afford rapid deployment to ground. Ensure that the weight is fastened with a snap link for easy removal by the evacuee.

The deployment bag is another method for storing and deploying the 120-foot nylon rope; however, this is only used with Stabo rigs. The material utilized in making the deployment bag is: two 18″ x 18″ pieces of cotton duck, two 2″ x 24″ nylon webbing, one D-ring and two butterfly snaps. Once you have constructed the deployment bag, S-roll the rope inside of the bag in the same manner as in the Griswald container. For best deployment S-roll the rope from top of the deployment bag to the bottom, then back to the top. When you use the deployment bag first fasten the standing end of the rope to the inside of the helicopter by one of the methods previously discussed. The exposed standing end should be covered with cotton duck. The entire deployment bag is then thrown from the helicopter to the ground. The weight of the bag with pipe sewn into the bottom and the 120-foot nylon rope should be sufficient to carry the end of the rope to the ground; however, if this should prove insufficient, fasten additional weight on with the butterfly snaps.

The rigs frequently employed in Vietnam for emergency extractions are: the Maguire, Palmer and Stabo. The Maguire rig is probably the simplest and easiest to assemble, but it is not always the safest. A Maguire rig is made with an 8-foot by 2-inch piece of nylon webbing sewn together at the ends to form a loop. Then the loop is fastened to the end of the 120-foot nylon rope with a D-ring. Sew a smaller slip loop 12 inches down from the top of the larger loop to form a wrist loop. During extraction with a Maguire rig the rider simply sits in the bottom of the large loop and places his wrist in the smaller slip loop. The slip loop

Continued on page 30

The Maguire rig though the simplest and easiest to assemble is not always the safest



Turbine Engine Supply Management

Those individuals who were involved in any way with aircraft maintenance and supply operations in the Republic of Vietnam in early 1968 during and after the 1968 Tet offensive will recall a critical shortage of turbine engines (as well as other aircraft parts). Increased operations caused a situation wherein it was "normal" not to have an engine available when required. This situation continued until mid-1968 when things improved, and in late 1968 engines could be found in stock under the aircraft intensive management item (AIMI) program at direct support units. The story behind this improved supply situation is told here

Lieutenant Colonel Kenneth E. Kellogg

IN EARLY 1968 a critical shortage of T53 and T55 engines for UH–1 and CH–47 helicopters began to develop as a result of increased operations in the Republic of Vietnam (RVN). To solve this problem it was recognized that new and intensive management at all levels was required. The new management began with an initiation of a dedicated air transportation system to move critical turbine engines to RVN and return unserviceable engines to the Continental United States (CONUS). The first flight departed CONUS for RVN on 29 May 1968. Serviceable engines were collected at the Aeronautical Depot Maintenance Center (ARADMAC), Corpus Christi, TX, for direct airlift by special assignment airlift movement (SAAM) C–141 aircraft to Vietnam. (Some flights were also made from Charleston, SC, the site of a contract overhaul facility.)

In RVN, on the other end of the pipeline, unserviceable turbine engines were collected at the airport of entry in sufficient quantities to assure full use of the C–141 capacity on return trips to ARADMAC. Initially all flights landed at Tan Son Nhut airport in Saigon. Later flights alternated between Tan Son Nhut and Phu Cat for distribution in the northern areas of RVN. The program was later expanded to cover all turbine engines, not just the T53 and T55 engines.

Authorized engine pipelines (time enroute to depot for overhaul, overhaul time and time enroute back to the field) were not immediately reduced. This was because of the large number of agencies involved; complications of marrying up new production and overhaul schedules with surface and air transportation and the coordination required;

and needed modifications to the system. It was believed that at least 1 year's experience would be necessary prior to making any significant decrease in the pipeline. For example, in CONUS serviceable engines were accumulated at Corpus Christi from the ARADMAC overhaul facility and from AVCO Lycoming at Stratford, CT, and Charleston, SC. Transportation people at the U. S. Army Aviation Systems Command (AVSCOM), the Army Materiel Command (AMC) and the Military Traffic Management and Terminal Service (MTMTS) had to coordinate and arrange for intra-CONUS air and truck transportation to Corpus Christi. The Military Airlift Command (MAC) had to arrange for air transportation to and from RVN. In Vietnam the 34th General Support Group (Aircraft Maintenance and Supply) and its inventory control center for aviation materiel in RVN, the Aviation Materiel Management Center (AMMC), had to assure that sufficient unserviceable engines were onhand at offloading aerial terminals for immediate onloading to use the full capacity of C–141 return flights to CONUS.

The dedicated transportation system became an immediate success, both responsive and economical. One-way transmit time for engines between CONUS and RVN by channel airlift was reduced from 10 days to 33 hours. Red ball requisitions for engines previously being received daily were no longer required. Three hours after the C–141 aircraft unloaded the inbound engines in RVN the aircraft were reloaded with unserviceable engines and ready for direct delivery to ARADMAC.

Early in fiscal year (FY) 1970 it became apparent that with the large scale continuing operation in Vietnam aviation logistics required a definitive review. The fact that aircraft inventory and operations were at a peak and logistic support had been geared to meet these requirements dictated a hard look at aircraft and support inventories and related procurement and overhaul programs. Two actions were taken: a panel of aviation logistics specialists was convened at AVSCOM by General Jack Norton in August 1969. This panel had representatives from the Department of the Army, AMC, AVSCOM and ARADMAC and concentrated on things that required doing. Then in September 1969 the aviation closed loop conference put teeth into those panel recommendations that were approved by incorporating them into the closed loop program. For example, the gas turbine engine overseas pipeline was reduced from 8 to 7 months.

As a result of the pipeline reduction the following actions were taken to reduce the procurement of engines:

- 330 T53–L13 spare engines were diverted to airframe manufacturers for UH–1/AH–1 aircraft as Government furnished materiel (GFM) for installation in new aircraft. Contracts for new engines were reduced by $20,895,750 as a result of this action.
- The requirements for spare T53–L13 engines were reduced by 491 for a savings of $31,945,000.
- 72 spare engines (T55–L11) were diverted to airframe manufacturers as GFM for installation in CH–47 helicopters for reduction in procurement and a savings of $4,044,000.

These three actions saved a total of 56.885 million dollars. These savings were reported by AVSCOM and validated as part of the Army's resources conservation program, previously called the cost reduction program. The validated savings of 56.885 million dollars for FY 1970 contributed a significant 13 percent of the Army's total validated savings of 441.8 million dollars in FY 1970.

In addition to the direct contribution of the SAAM flights to reduction of the engine pipeline, several other actions also were major contributors to the reduction. A "dedicated" truck transportation system for transfer of engines within CONUS was established and an engine transit manager position was created at AVSCOM. These innovations served to assure more rapid and economical shipments. Intensive management concepts, techniques and procedures were used to reduce the pipeline for serviceable engines within RVN. Improvements were made in the aircraft component intensive management system (ACIMS) which is the Army's serial number reporting system for aircraft engines (over 10,000) and high value components, in order to provide better controls over engines worldwide including those located below DSU level. These controls provided for a reparable manager at the DSU level responsible for issue and return of aircraft engines and components.

Additional studies are underway to determine if further efficiency and savings can be made in transporting aircraft engines. Development and procurement of lightweight containers to allow more engines to be shipped per MAC aircraft is now underway. The shipment of engines in racks rather than cans—or in cans with the tops removed—are other projects being considered to reduce the shipping weight of each engine to permit a greater number of engines per airlift.

Through the efforts on the parts of numerous agencies and individuals at all echelons a significant improvement in logistical support of Army aviation has been accomplished.

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Through the efforts on the parts of numerous agencies and individuals at all echelons a significant improvement in logistical support of Army aviation has been accomplished.

The author is a retired lieutenant colonel, who once served as a member of an Army aviation research project as a data collector. The purpose of the project was to find some means to enhance the survivability of Army aircraft. It was the author's duty to interview the helicopter crewmembers of ships that received hits during a mission. When it was possible the crewmembers of the wing ships or another similar ship on the same mission that did not receive a hit were also interviewed for comparison purposes

Another Helicopter Concept

Lieutenant Colonel James Angeles (Retired)

THE MOST significant observation I have made as a member of a research team interviewing helicopter crews in the Republic of Vietnam is the simple fact that rarely if ever does any member of a helicopter crew physically see the Viet Cong during an engagement. Aircraft have received hits, have been shot down and crews have returned fire until completely expended without ever having seen the enemy. This problem is not unique as allied ground troops suffer the same problem. Phrases coined in this war bear out this observation: *search and destroy—search and clear*. Search, search—that's the name of the game.

In populated areas the VC literally melt into a sea of sameness. On the battlefield it is the enemy's mastery of cover and concealment practiced in a topography and terrain ideally suited to his purpose that makes him an elusive, dedicated fighter. The hunters seldom are afforded the opportunity to bring aimed fire on the hunted. We have superior weapons, know-how, mobility and numbers to use against his small arms, cover, concealment and motivation. Yet he survives. He nullifies our overwhelming superiority by simple, expedient cover and concealment. We find ourselves reacting to his tactics and he invariably gets in the first blow. We have developed ingenious tactics and weapons in our search for

Although the technique proposed by the author incorporates overflight of the target, which is contrary to current methods of employment of attack helicopters, it does provide a thought-provoking concept. The DIGEST invites your comments on the article

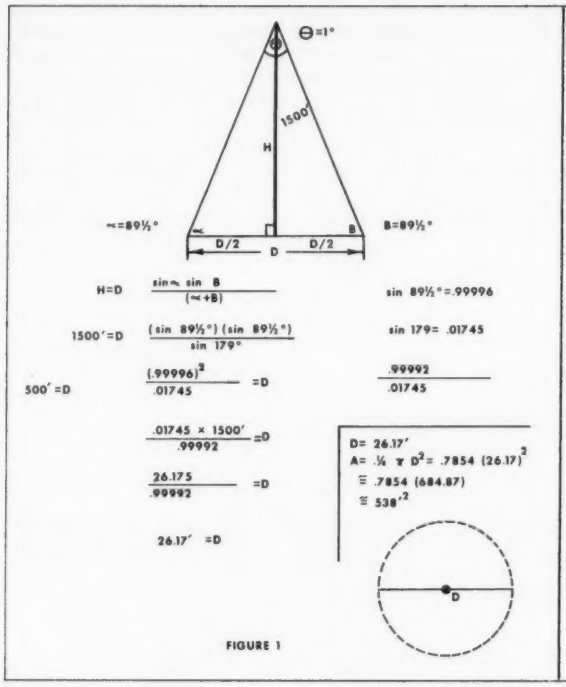


FIGURE 1

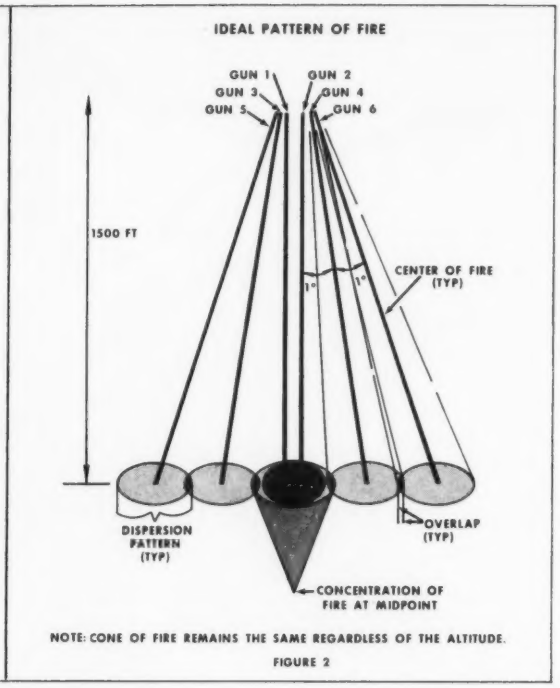


FIGURE 2

victory, but he continues to elude us. It is time to explore new methods of attacking the enemy, and I offer one below. But first one must understand the secrets of Charlie's success.

The military definition of cover is a shelter for protection—to protect as by shielding. Except for a direct hit the foxhole provides adequate protection against all the sophisticated weapons of today. Even on the nuclear battlefield it remains the simplest and most effective defense against blast, thermal and radiological effects. By providing the crudest refinement of an overhead cover the protection afforded is greatly increased. In Vietnam the enemy uses cover for his very survival. He prepares "spider" holes, bunkers, underground chambers, etc., and conceals his cover by the use of camouflage and camouflage discipline at its best. When threatened he disappears from view. If he chooses to fight he fights best from cover.

Militarily, concealment is a passive defense offering no physical protection. To conceal is to hide. The art of concealment in modern warfare has become highly sophisticated, but as the level of warfare decreases the art of concealment is simplified. For example, guerrilla warfare cannot exist without the *means* of concealment. Development in the skills and techniques of concealment as related to topography and terrain can in itself become the most effective weapon an adversary can possess—this despite the fact that it offers no protection whatsoever.

Obviously cover combined with concealment and a suitable area are the ingredients for successful guerrilla warfare. In areas known to be occupied by the enemy, the VC cannot be found. If Charlie chooses not to fight he abandons his cover and hides. He is careful to always prepare his position in an area with a suitable avenue of escape. He often fires from concealment and depends on the topography and terrain to mask his movement. Unless he panics and runs he is comparatively safe as most fire brought to bear on him is unaimed and its effectiveness totally dependent on chance.

Engagements in Vietnam are replete with incidents where the enemy is fired on but never seen. Let me cite two such cases.

Friendly troops are pinned down by the enemy in an area where 15 or 20 VC are seen moving into an area of tall grass. Helicopter gunships are called in and the area Charlie has entered is marked with smoke. The gunships attack the area repeatedly without seeing the enemy. When the aircraft leave the enemy resumes firing on the friendlies. It is logical to assume that the attacks were delivered in the correct area and in the correct manner but by chance failed to strike the enemy.

In a second case the enemy, although not physically seen, is

known to occupy a bunker along a tree line. Air strikes are pin-pointed on this target. The enemy does not return fire from this point, however, the aircraft is taken under fire from other directions, unobserved and undetected.

What is the answer? Deprive the enemy of his cover and concealment. By way of illustration I will present one method involving Army helicopters that will deprive the VC of his cover and concealment.

Evolution of weapons systems for fighter aircraft were designed for aerial combat, aircraft against aircraft, to gain air supremacy. The system that evolved was the expedient of using the aircraft as an aiming device. Weapons were mounted on the aircraft that fired straightforward on the same plane as the flight of the aircraft. With minor exception this principle has remained in effect to this day. This same principle was used in the development of the helicopter fire support system commonly called the "gunship." Although some gunships do afford a degree of lateral and vertical movement in the firing of their weapons, basically they must still "aim" the aircraft.

Fire delivered by "aiming the aircraft" is concentrated in a small area—that at which the aircraft is pointed with some dispersion of course. It can conceivably be used to strafe along a given line, increasing the size of the area brought under fire. All fire is delivered at an angle. The infantryman's friend, the foxhole, provides adequate protection. A rice paddy wall, a tree, a depression in the ground also provides protection at least from the direction of attack. Keep in mind that the aircraft is vulnerable during the attack run.

Let's discard this concept!

Let's develop a fire system that delivers fire vertically—straight down. Use a helicopter as a firing platform. Mount three miniguns on each side of the helicopter. Synchronize the inboard guns to fire straight down. Offset the next two 1 degree from center and the outboard guns 2 degrees from center. At 1,500 feet elevation a strip approximately 100 feet wide would be saturated with 24,000 rounds per minute (4,000 rpm per gun) for a distance of 1 mile if the aircraft traveled at a rate of 60 miles per hour (figure 1). The dispersion factor is not included; however, it would increase the width of the strike zone by the dispersion factor for the weapon. The above settings for the guns were selected arbitrarily and serve their function by demonstrating the means of obtaining the dispersion required. Ideally the dispersion of each gun should overlap the next to ensure complete coverage (figure 2). A brief test phase would determine the correct setting for the best desired effect.

Flexibility is afforded the selection of fires to be delivered by varying the speed of the aircraft, its altitude and the guns' rate of fire. If light coverage over a large area is desired (suppressive fire in preparation of a landing zone) increase the altitude, speed or both. If a high volume of fire is desired (heavy concentration of the enemy along a tree line) reduce the altitude, speed or both. The dispersion factor and high volume of fire would cover the area like a blanket. What are the chances of survival under these conditions without overhead cover?

Let the imagination run wild. What would be the effect of .50 caliber machine guns, 20 mm cannon or 40 mm grenades? What type of aircraft could be used—the AH–1G HueyCobra gunship, the UH–1H, the Navy's twin-engined UH–1N or perhaps the CH–47? How many aircraft—two per assault helicopter company, one platoon per combat aviation battalion or one company at group level?

Think for a minute what the effect would be if this concept were used against the U. S. Army in Vietnam by the enemy, perhaps on a fire base, a battalion in the open or an airfield? The mere thought of one successful enemy attack is horrendous and quickly put out of mind.

In essence what is presented here is an area weapon. To aim the system requires only that the aircraft pass over the target area. Thus the enemy has been effectively deprived of his cover and concealment except for those in fortifications with overhead cover. Just as important is the fact that if the enemy is safe only in fortified positions he also has lost his mobility. The search would be more fruitful as Charlie has been "fixed" in his bunkers. An added feature is the comparative safety of the aircraft during the attack run.

A new field would be opened for the ballistic experts in determining the effects of a projectile fired without the adverse effects of gravity. Surely the results would prove beneficial and add credence to the concept.

It also would be well to explore the possibilities of this vertical attack concept in conventional warfare. The mere threat would require a massive air defense effort and completely change passive defense measures as we know them today. Overhead cover would be a requirement for all installations and activities. Where overhead cover cannot be provided the risk would be obvious. A motor convoy could be cut to ribbons. Imagine the results of such an attack on a motor pool, a forward airstrip, a fuel depot, a shipyard—you fill in the rest.

I think the concept would work in Vietnam and in the area of conventional warfare. Only one question remains: Will someone pick up the ball and run with it?

Maintenance

WHEN INSTALLING BATTERY COVERS

Correct Installation Of The Nickel Cadmium Battery Cover: Proper installation of the nickel cadmium battery cover is very important. Failure to properly install this cover may result in damage to aircraft, maintenance equipment and personnel loss of life or limb. To preclude any such *incidents* taking place, each person having responsibilities for maintenance and upkeep on the nickel cadmium battery should consult TM 11–6140–203–15–2 for proper maintenance procedures.

If the battery cover is installed improperly and doesn't allow the vent port to release hydrogen and oxygen gases overboard, static electricity can cause accidental ignition of the hydrogen gas resulting in an explosion. Buckling of lids and cracked cases are not uncommon due to improper installation of the lid cover. Before installing the quick disconnect battery cable to the battery, make sure the cover is in the proper position. Proper positioning will cut down on the possibility of an injurious accident.

★ ★ ★

Defueling Aircraft: Defueling aircraft requires the utmost safety precautions. Due to the highly flammable characteristics of fuel, personnel shall be well informed of the steps to take in case of an emergency to prevent hazardous injuries.

• Do not operate any open flame device, reciprocating engines or jet engines within 50 feet of aircraft being defueled.

• Manpower used in defueling operation shall be held to a minimum, but be adequate to stop all servicing equipment in the event of an emergency.

• Notify service unit operator, as accurately as possible, of the amount of fuel involved in each operation.

• Position service unit as far away from aircraft as hose will permit and in a position so that it may be driven or towed away from the area in the event of an emergency.

• Visually check fuel hose for breaks or worn spots. Replace damaged hose before defueling.

• Fuel servicing unit attendant shall not leave servicing unit while it is connected to aircraft.

• Ground aircraft when defueling. When defueling operation is complete, disconnect grounding cables in reverse order of attaching.

• Personnel handling fuel hose nozzle shall discharge static electricity from their persons before handling or touching metal in vapor area.

• Do not block nozzle in open position. Nozzles will be operated manually at all times.

• Open and close nozzle valve slowly to prevent kickback of nozzle and high-pressure surge.

• Position a person on top of servicing unit to observe fluid level and prevent overflow.

• Use only properly marked and electrically grounded contain-

Matters...

Furnished by the Department of Maintenance Training, Ft. Rucker, AL

ers when manually draining fuel from tanks.

• A standby fire truck is recommended during the complete defueling operation.

• Tank filler caps will be removed and all sources of spark or flame prohibited.

• Under emergency conditions or where the aircraft cannot be moved defueling operations may be accomplished inside a hangar. When defueling operations are carried on inside a hangar, the main doors will be open and all shop doors leading into the hangar closed.

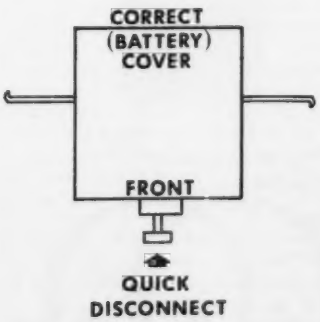
★ ★ ★

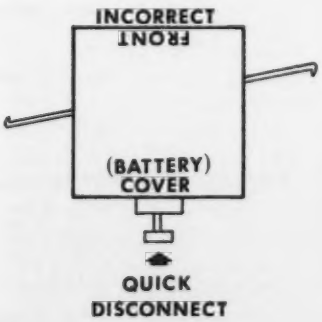
Equipment Improvement Recommendations: Stay with them! They are important and do play a big role in maintenance. Unless there are numerous reports on the same item it cannot be assumed that an unreliability trend exists. All EIRs are considered, evaluated and recorded. Therefore, it might take several EIRs from various sources before a trend can be established and action taken. Also, for a positive identification of components, etc., make sure you write down both the Federal stock number and the manufacturer's part number; they are both important.

★ ★ ★

Tag It, Don't Just Bag It: Fuel regulators or governors that are removed from service must be properly tagged as to reason for removal, time since new, time since overhaul and DA Form 2410 control number using the appropriate DD Materiel Condition Tag as prescribed in TB 750–126. A DA Form 2410 prepared and processed in accordance with TM 38–750 must be completed in addition to the appropriate tag.

NOTE: Improper handling, including failure to record time or reason for removal, could result in unnecessary expenditures to return the unit to CONUS for repair and then return of the repaired unit to RVN or another area.



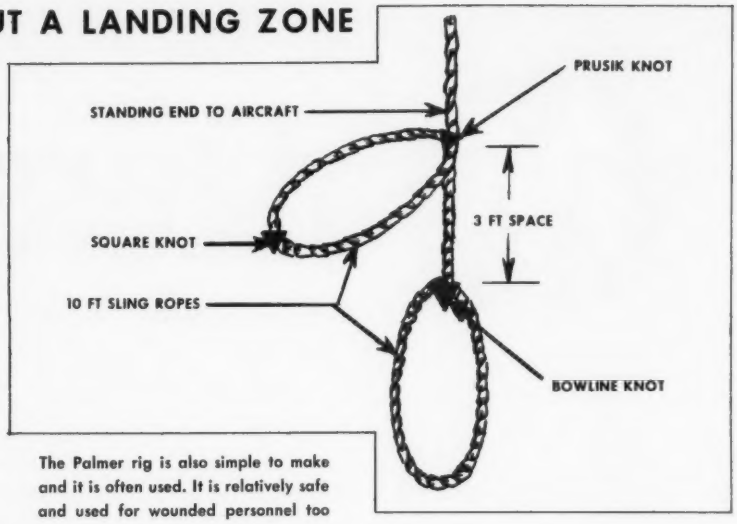


EXTRACTION WITHOUT A LANDING ZONE

Continued from page 21

tightens on the wrist ensuring that the rider does not fall from the larger loop during extraction.

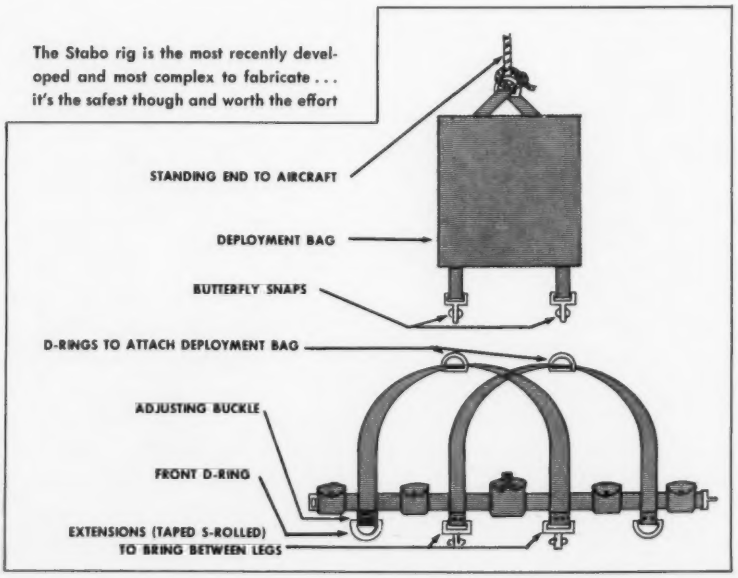
The Palmer rig is also a simple extraction rig which is often used. It is constructed with a 120-foot nylon rope and two 10-foot nylon sling ropes. The running end of the 120-foot nylon rope is tied with an end of the rope bowline knot. Tie a sling rope on the 120-foot rope with a Prusik knot 3 feet above the bowline knot, with the loose ends tied in a square knot to form a loop. With the Palmer rig the rider must use the remaining sling rope to form a climber rappel seat. He then fastens a snap link to the rappel seat and to the bowline knot on the end of the 120-foot nylon rope. The final step is to place your arms up and through the loop formed by the Prusik and square knots. The Palmer rig is relatively safe and may be used when evacuating wounded personnel.



The Palmer rig is also simple to make and it is often used. It is relatively safe and used for wounded personnel too

The Stabo rig is the most recently developed emergency extraction rig. This is a more complex piece of equipment to make but is by far the safest. The Stabo rig fastens to the combat belt and is worn in lieu of the normal suspenders of the infantryman. On top of the suspenders are two D-rings (a) for hooking up to the 120-foot extraction rope. Adjusting buckles (b) are located on the front of the suspenders to lengthen or shorten the strap. The lower rear of the suspenders have two extensions (c) with butterfly snaps (d) for bringing up between the legs and fastening to two D-rings (e) on the front of the suspenders (Stabo rig). For comfort the rear extensions are usually S-rolled and taped. This is to ensure that the straps do not cause irritation between the legs while walking. The butterfly snaps are easily attached by a downward jerk on the straps and bringing them between the legs to fasten on the front D-rings. With prior planning by the commander the final step for the evacuee, which applies to all previously discussed methods, will be to hook up and signal the extraction helicopter to begin his ascent. Once he has cleared the trees he will be flown, suspended from the 120-foot nylon rope, to the nearest secure landing zone.

All of these relatively simple extraction rigs are currently being employed in Vietnam. Regardless of the command that you are in, the knowledge of the equipment and the techniques can save a life that otherwise would have been lost.



The Stabo rig is the most recently developed and most complex to fabricate . . . it's the safest though and worth the effort

VIEWS FROM READERS

Continued from page 1

(not emergency) flight if the weather is below the landing minima for that field or one nearby. This would not be a reflection on the ability of the pilot to make the takeoff safely but rather to provide a reasonable course of action in the event of fire, etc., on takeoff. I believe that it would be reasonable to allow a commander to designate certain individuals, who have proven their capability, to take off on emergency missions down to and including zero/zero. Another item that is seldom discussed is the area of enroute ceilings for IFR flight. We put a lot of emphasis on knowing "where to put it down" in VFR conditions but we forget that our helicopter engines are rather ignorant and don't understand that they should never quit while in the clouds. Would it be unreasonable to set a minimum enroute ceiling for routine instrument flights, especially in single engine aircraft?

On question 36, "Flights into weather below 1,000 feet and 3 miles visibility should be cleared by the aviation unit commander or his designee," I believe that the solution here would be to set qualification requirements for both the aviator and the aircraft. I would suggest requiring, particularly at night, that both pilots be instrument qualified and *current* and that the aircraft be fully instrumented for flights in weather below 1000 and 3. The benefits from this would be twofold. First, it would do much to eliminate the waste and tragedy of weather accidents. Secondly, it would force all of us (aviators, commanders, and maintenance personnel) to honestly evaluate our capabilities in both personnel and equipment. When we try to conduct marginal weather operations with inadequately trained personnel and inadequately equipped aircraft, it could be compared to a man who tries to paint a rusty car without first removing the rust and applying primer. It will look good for a few days but eventually the rust will eat through, only in our business it will be much more serious.

CW3 Carl L. Hess
WOCAR
Ft. Rucker, AL 36360

INSTRUMENT CORNER

Q. If a pilot on an IFR flight plan cancels IFR and proceeds to destination VFR, must he refile a VFR flight plan with FSS?

A. An IFR flight plan may be canceled at any time the flight is operating in VFR conditions outside positive controlled airspace by the pilot stating, "Cancel my IFR flight plan," to the controller or air/ground station with whom he is communicating. Immediately after canceling an IFR flight plan, a pilot should take necessary action to change to appropriate: air/ground frequency; VFR radar beacon code; VFR altitude/flight level. ATC separation and information services will be discontinued including radar service (where applicable). Consequently, if the canceling flight desires VFR radar advisory service the pilot must specifically request it. In addition, pilots must be aware that other procedures may be applicable to a flight that cancels an IFR flight plan within an area where a special program has been established, e.g., a designated Terminal Radar Service Area or Terminal Control Area.

If a DVFR flight plan requirement exists, the pilot is responsible for filing this flight plan to replace the canceled IFR flight plan. If a subsequent IFR operation becomes necessary, a new IFR flight plan must be filed and an ATC clearance obtained before operating in IFR conditions.

This then is the guidance given in the Airman's Information Manual, Part I, (Nov 71), page 1-50.

There is no specific guidance as to whether or not a new VFR flight plan should be filed. This is due to the fact that civilian flying does not require a VFR flight plan. Also, it should be noted that the phraseology used here specifically mentions "flight plan."

If it is the intent of the pilot to cancel the IFR portion of his flight plan and proceed VFR, he should not use the phrase stated above. Therefore, looking to AR 95-2 which says: (para 3-15c) Change flight plan, IFR to VFR. An aviator operating with an IFR traffic clearance may cancel such clearance and proceed under VFR provided he is operating in visual flight conditions when such action is taken. The appropriate ATC agency will be advised as soon as possible.

Phraseology is not given here. However, coordination with an FSS conveying your intent will ensure that you are still on a flight plan and flight following will continue.

Reference: AIM, Part I, AR 95-2, USAASO

Q. Recently while taking my annual instrument checkride my examiner chastised me for making a teardrop procedure turn. Is a teardrop procedure turn authorized?

A. If on the approach plate you were using a barb was depicted for the procedure turn, you were well within your rights. A barb indicates the direction or side of the outbound course on which the procedure turn is made. Headings are provided for course reversal using the 45 degree type procedure turn. However, the point at which the turn may be commenced and the type and rate of turn is left to the discretion of the pilot. Some of the options are the 45 degree procedure turn, the racetrack pattern, the teardrop procedure turn, or the 80 degree to 260 degree course reversal.

Reference: AC No 90—1A, page 18, para (g) *1*
TM 1-225, page 13-7, para 13-9c

A New L/MF Beacon—

Low/Medium

AN/TR

Beacon set, radio, with overall view. Showing tactical/semifixed mode, with 60 foot antenna

ONE OF THE SIMPLEST and most effective navigation aids used by U. S. Army aircraft for general navigation (enroute and terminal) has proved to be the omnidirectional low frequency ground beacon. The low frequency beacons now being used by the Army are the AN/GRN–6, which is old, bulky and difficult to maintain, and the AN/TRN–25, a commercial off-the-shelf type. Both have proved to be unreliable and unsuitable for pathfinder or tactical operations.

Hence, there is no military item in existence that fulfills the Army's need for a low medium frequency (L/MF) beacon that is capable of worldwide operation in a military environment and in all modes of operation from pathfinder, tactical or semifixed installations.

Recognizing this deficiency the Avionics Laboratory, U. S. Army Electronics Command, Ft. Monmouth, NJ, has recently completed development of the AN/TRN–30 (XE–1)(V) (figure 1), a new L/MF beacon that represents application of state-of-the-art technology and employs miniaturization whenever possible. Several models of this equipment are undergoing engineering test and service test (ET/ST) evaluation to determine suitability for troop issue. The design concept was to provide a rugged, reliable, quickly erectable and easily transportable set that offered the best compro-

Frequency (L/MF) Beacon

N-30(XE-1)(V)

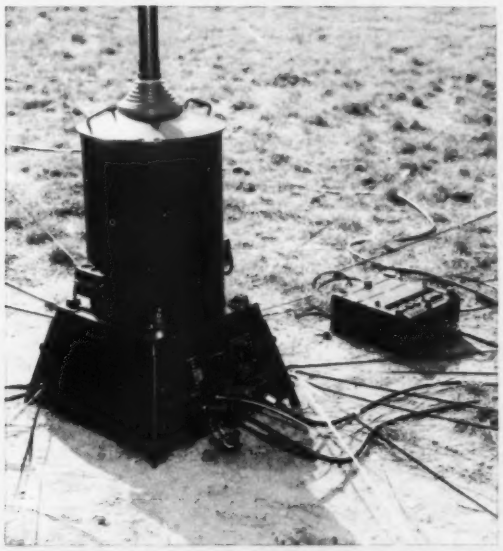
Anthony M. Marzano

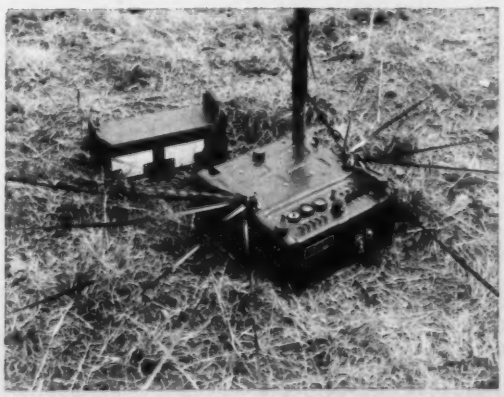
mise of weight, required power and maximum range.

The AN/TRN–30 L/MF beacon set, employed in conjunction with the available aircraft automatic direction finders (ADFs) such as the AN/ARN–59, AN/ARN–83 and AN/ARN–89, will provide area navigation information. The navigation information (bearing and indication of station passage) obtained will be correlated to topographical or aeronautical charts to determine position.

The radio beacon set provides an amplitude modulated (AM) radio frequency (RF) signal on any one of 964 channels in the frequency ranges from 200 to 535 kilohertz (kHz) and 1605 to 1750 kHz in tunable increments of 500 Hz. The RF output is modulated by a 1020 Hz tone which is automatically keyed to form Morse code characters in four-letter groups which are selected by the operator or manually keyed as desired. The radio beacon set has a transmission range of 15 to 100 nautical miles and a power output of 25 to 180 watts radiated from a 15-, 30- or 60-foot antenna, depending on the configuration or mode of operation utilized. It can be used in two basic configurations: pathfinder AN/TRN–30 (XE–1)(V) 1, and tactical and semifixed AN/TRN–30(XE–1) (V) 2.

In the pathfinder configuration (figure 2) the Transmitter, Radio





Above, beacon set, radio, 60 foot antenna showing amplifier-coupler and transmitter, radio. Below, beacon set, radio, and ¾ view of pathfinder mode, 30 foot antenna; shows transmitter, radio and battery with ground radials and antenna inserted in transmitter

TECHNICAL DESCRIPTION

FEATURE	MODE		
	PATHFINDER (a) Primary Ant. (b) Auxiliary Ant.	TACTICAL	SEMI-FIXED
Operating Range at ADF alt. for 50 uV meter	(a) 25 NM @ 500 ft. alt.	50 NM @ 1000 ft. alt.	100 NM @ 1000 ft. alt.
Aux. Ant.	(b) 15 NM @ 500ft. alt.		
Freq. Bands	(a) 200 KHz to 535 KHz (b) 1605 KHz to 1750 KHz	200 KHz to 535 KHz	200 KHz to 535 KHz
Power Output	25 watts	60 watts	180 watts
Frequency Steps	0.5 KHz	0.5 KHz	0.5 KHz
Number of Channels	964	672	672
Freq. Stability	± .0001%	± .0001%	± .0001%
Emission – Tone automatically or manually keyed	CW or MCW	CW or MCW	CW or MCW
Power Amp. % Modulation, min.	50–85%	65–85%	65–85%
Modulation Freq.	1020 Hz ± 10 Hz	1020 Hz ± 10 Hz	1020 Hz ± 10 Hz
No. of Morse Code Letters	26 + blank	26 + blank	26 + blank
Combination of Letters	1, 2, 3, or 4	1, 2, 3, or 4	1, 2, 3, or 4
Words/Min. Adj.	7 to 20	7 to 20	7 to 20
Input Power: Ext. Source Volt.	Normal 26 to 30 V Abnormal 20 to 30 V	26 to 30 V 20 to 30 V	26 to 30 V 20 to 30 V
Ext. Source Cur. Int. Batt. Voltage Int. Batt. Hrs. of Operation	3 amps. 24 + 4, −2 V 6	7.6 amps nom.	22.8 amps. nom.
Max. Antenna Height	(a) 30 ft. (b) 15 ft.	60 ft.	60 ft.
Ant. Polarization	Vertical	Vertical	Vertical
Harmonic/Spurious Output Outside Emission Bandwidth of $f_o \pm 5\%$ Per MIL-STD-461	-58 DBW	-60 DBW	-60 DBW
Beacon Weight:	32.5 lbs.	157 lbs.	157 lbs.

TABLE I

Beacon set with radio and overview. Showing pathfinder mode with 30 foot antenna

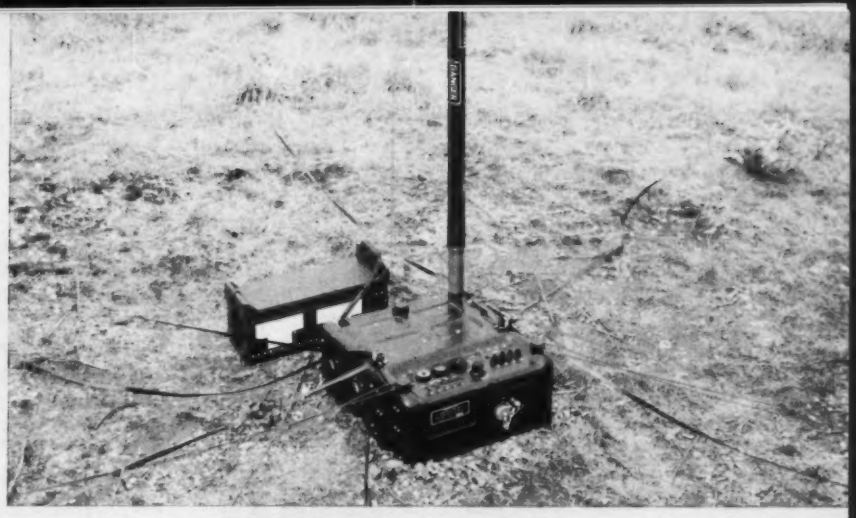
T–1199(XE–1)/TRN–30(V) is a low power, short range, manportable, direction finding beacon. The primary power (+24 vdc) is supplied by Battery BA–525( )/U which is connected to the transmitter by a 14-inch cable. The pathfinder configuration provides for either low power, short range operation using a 15-foot centerloaded antenna, or medium power, medium range operation using a 30-foot top-loaded antenna.

In the tactical and semifixed configuration (figure 3) the radio beacon set is set up in a semipermanent installation and used as a medium-to-high power and medium-to-long range direction finding beacon. Amplifier-Coupler AM–6417 (XE–1)/TRN–30(V) is connected to the Transmitter, Radio T–1199(XE–1)/TRN–30(V) with two 6-foot cables. Primary power is supplied from an external +28 vdc power source which is connected to both the transmitter and the amplifier. The tactical mode of operation provides for the selection of any one of three power amplifiers; the semifixed mode of operation combines the output of all three power amplifiers and feeds it into the 60-foot antenna AS–2634(XE–1)/TRN–30(V).

Table I gives the characteristics of each mode of operation.

Table II is a comparison of the AN/TRN–25 lower power unit and the AN/TRN–30 pathfinder configuration. The increase in number of channels, longer range improved frequency stability, improved reliability and capability of meeting the worldwide military environment is of significance. In the tactical/semifixed configuration (160 pounds) the AN/TRN–30 will replace the AN/GRN–6 which weighs 1,550 pounds. Successful design and development has permitted the combination of the tactical and semifixed units into a single configuration which meets all the weight and size constraints of the smaller tactical unit.

The overall achieved design features are: completely solid state; automatic antenna tuning; demonstrated mean-time-between-failure (MTBF); pathfinder, 1,500 hours; tactical/semifixed, 1,000 hours; transient and overload voltage protection; maximum use of plug-in cards to facilitate maintenance;



Above, beacon set, radio, overall view, showing pathfinder mode 15 foot antenna. Right, beacon set, radio, ¾ view of pathfinder mode and a 15 foot antenna. Showing transmitter, radio and battery with ground radials; antenna base and guy lines are in snubbers

and easily accessible test points. The antennas are of a lightweight collapsible design and are capable of meeting wind performance of 55 knots with gusts to 85 knots. One man can erect the 15-foot auxiliary antenna in 5 minutes and the 30-foot antenna in 20 minutes. Two men can erect the 60-foot antenna in 60 minutes, however, four to six men are recommended. The equipment was developed for the U.S. Army Electronics Command under Contract No. DAAB07–69–C–0320 by Hoffman Electronic Corporation, Military Products Division, El Monte, CA.

Upon successful completion of ET/ST the AN/TRN–30 will be approved for troop issue and Army aviation units and pathfinder units will employ this equipment at base airstrips and remotely dispersed landing facilities where heavier aids such as GCA equipment are not available or are impractical. This equipment should significantly enhance Army operations while offering major improvements in reliability and maintenance at reduced costs.

COMPARISON OF EQUIPMENT PARAMETERS

	*TRN-25 (Low Power)	TRN-30 (Pathfinder)	Tactical/S/P
Freq. Coverage:	265-535 KHz	200-535, 1605-1750 KHz	671
Number of Channels:	271	962	671
Power Output	10 watts	25 watts	60 w./180 w.
Antenna Height:	50'	Primary–30' Aux. –15'	60'
Radials:	18 x 50'	16 x 60'	16 x 60'
Battery Type:	Silver-Zinc	Zinc-Air	28v. D. C. External
Hours of Operation:	4 hours	6 hours	10 hrs/day, 10 days no maintenance
Identifier Codes:	8100 4-letter 900 3-letter 100 2-letter	26^4 –46,000	Same
Spec. Range:	20 NM at 500' at 20 uV/meter	25 NM at 500' at 50 uV/meter	50 NM at 1000 ft. at 50 uV/meter 100 NM, etc.
% Mod. at Trans.:	80%	50% near 200 Khz, 85% all others	65–85%
Approx. Weight:	37.5 lbs.	32.5 lbs.	160 lbs.
Antenna Wind Performance:	35 knots (Estimated)	55 knots with gusts to 85 knots	Same
Radiated Harmonics and Spurious	Does not meet MIL-STD-461	66 db below carrier Meets MIL-STD-461	Same
Antenna Tuning:	Manual	Automatic	Same
Antenna Erection Time:	20 min. (1 man)	5 min. (1 man) 15' 20 min. (1 man) 30'	60 min. (2 men)
Frequency:	1 Khz steps	500 Hz steps	Same
Frequency Stability:	±0.01%	±0.0001%	Same
Reliability:	485 hr. MTBF	1500 hr. MTBF	1200 hr/1000 hrs. MTBF
Meet Worldwide Environmental Application (AR 705-15)	No	Yes	Yes

TABLE II

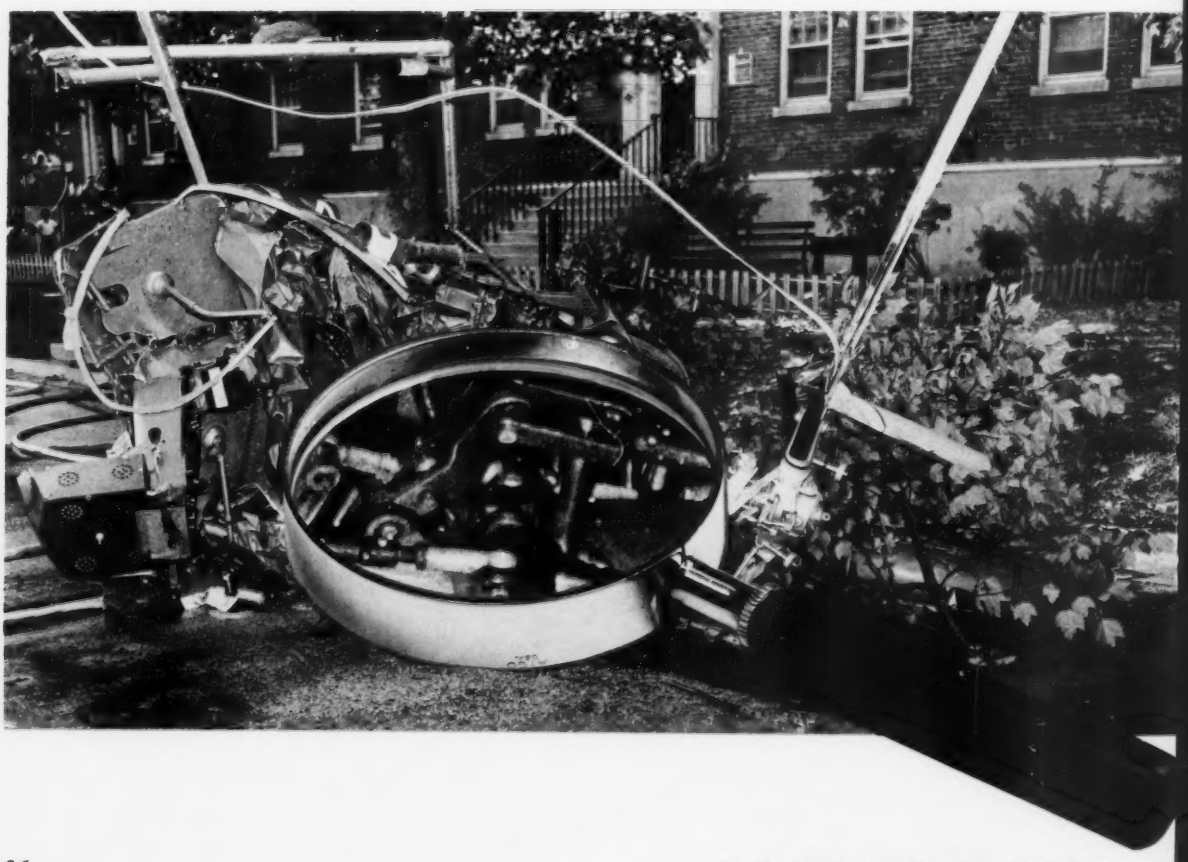
ACCURATE AND THOROUGH?

AR 95–5, chapter 6: ". . . Each accident investigation adds to the overall Army aviation accident experience, providing a basis for corrective action. Proper use of this experience will result in the elimination of accident potentials. Moreover, training deficiencies are disclosed, realistic maintenance requirements are determined, material is improved, future design criteria are established and many other long-range results are achieved through the use of accident history. The *accuracy* and *thoroughness* [italics ours] of investigation determines the adequacy of ultimate action taken to remove or eliminate factors that cause or contribute to accidents. . . ."

Ask yourself the title question as you review the following briefs and excerpts from two recent accident reports.

Accident No. 1: A UH–1H was flying a resupply mission to an infantry platoon.

Crew chief: "We went to the LZ in the morning



and dropped cases of C rations from above treetop level because we were unable to land. After lunch, we flew more logistical missions in the same general area.

"On the way back to the LZ, we picked up four passengers and approximately seven 5-gallon water jugs. We came to a hover over the LZ and began to lower the water jugs by rope. The gunner and I were clearing the tail and the rotor blades.

"The aircraft started to spin tail left and I told the aircraft commander to bring the tail to the right. The aircraft continued to spin tail left and crashed left front side first. When I got out, I helped remove the passengers and pilots. A dustoff ship made two trips to take out the five injured people."

Description: "The crew had been to the field site once in the morning and were forced to hover above the trees and drop supplies to the troops on the ground because the clearing was too small to land in. During the afternoon they proceeded back to the same site to resupply water.

"The LZ had been enlarged and allowed the ship to be hovered a few feet below treetop level. The gunner and crew chief were clearing the main and tail rotors. The crew chief told the aircraft commander to take the tail to the right and not to come back any more. The gunner advised there was very little room to maneuver the tail on his side.

"The aircraft commander then decided to depart the area and the ship started hovering up to clear the trees. It yawed right at that time and turned two and one-half times before impacting the ground on the left front side. It is unknown what corrective actions the aircraft commander took during the emergency. Impact occurred on the side of a ridge line in an 80-degree nose down, 90-degree left bank attitude. The aircraft was destroyed. The trees surrounding the LZ were from 100 to 150 feet high."

Analysis: "Based on statements from the enlisted crew members and ground observers (statements could not be obtained from the aircraft commander or pilot) and a survey of the wreckage, the cause of the accident was loss of antitorque control. It could not be determined whether it was caused by materiel failure or crew error. The 90-degree gearbox was never recovered. It's suspected the cause was crew error for three reasons: first, the crew members questioned could recall no loud bang or abnormal sound coming from the tail rotor drive or gearboxes; second, the ship was heavily loaded and hovering out of ground effect in mountainous terrain where wind direction and velocity often change; and third, the loss of antitorque control and subsequent yaw to the right occurred as the aircraft commander was applying power."

Findings: "The aircraft commander elected to go into an LZ that earlier in the day proved to be unsatisfactory for resupply drops due to obstacles. The LZ was insufficiently prepared to receive resupply by a UH–1H."

Recommendations: "That all pilots in the unit be made aware of the hazards of hovering out of ground effect in mountainous terrain where winds are often unpredictable.

"That the safety of aircrews, as well as personnel on the ground, be considered along with the importance of missions. In this case, the LZ could have been enlarged.

"That ground units supported by aviation be reminded of the hazards of improperly prepared LZs."

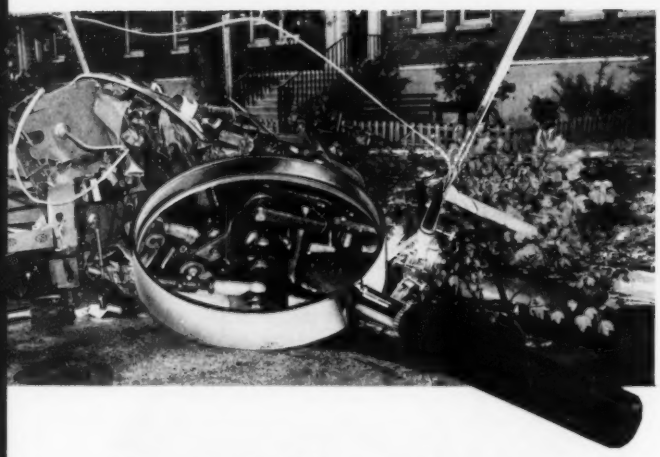
Flight surgeon: "A flight surgeon was not even notified about this accident until 7 days after it occurred. By that time, two of the injured crew members had been evacuated with their records and the third had been discharged back to his company. I recommend that existing SOPs on accident investigation and the role of the flight surgeon in them be much more strictly adhered to in the future."

Second indorsement: ". . . It is the general feeling of this command that the conclusions of the accident board are, at the very least, weakly substantiated. Ambiguous assumptions, such as no crew members hearing a loud bang or sound, or the fact that the aircraft yawed right as the aircraft commander was applying power, do not appear to be justification to imply the accident was caused by pilot error.

"Many mechanical failures can occur without giving any indication by noise or sound. As evidence, in this command, an aviator had a tail rotor stack bearing failure, causing complete loss of tail rotor control. When this occurred, the crew was given no indication of the failure by any loud noise or sound.

"In his statement, the platoon leader on the ground said the aircraft turned 360 degrees prior to striking a tree with the tail rotor, which would indicate a mechanical failure. It appears there is sufficient evidence to equally suspect materiel/mechanical failure as a primary cause of the accident. . . ."

Fourth indorsement: ". . . Disagree with the finding of pilot error. Investigation proved the aircraft had hovered in the LZ for 2 minutes prior to the antitorque failure. Had hovering out of ground effect and the weight on board been the primary cause of



the success of any aircraft accident investigation depends upon its organization and a comprehensive preaccident plan

loss of power and loss of antitorque control, the aircraft would not have sustained level flight for 2 minutes. It is therefore possible, although unprovable, that a mechanical failure did, in fact, occur. . . ."

Fifth indorsement: ". . . The aircraft was overweight for conditions. Chart 14–14, page 14–66, TM 55–1520–210–10, indicates that the maximum weight for hovering out of ground effect at 3,800 feet MSL and 30° C. OAT is approximately 7,700 pounds. The weight indicated on the DD Form 365F is 8,348 pounds.

"Corrective actions will include familiarization with performance charts in the dash 10."

Sixth indorsement: ". . . For statistical purposes, this headquarters has coded the cause of subject accident as UNKNOWN. . . ."

Accident No. 2: A UH–1H was on an administrative flight in a noncombat area with five people aboard.

Aircraft commander: "The tower cleared us special VFR westbound along the highway. As best I can remember, the weather was given as 2,500 meters in precipitation, ceiling 800 feet agl. Approximately 3 minutes after takeoff, the tower advised that another helicopter pilot trying to fly the highway eastbound had turned back due to weather. I answered that we had three-quarters of a mile visibility in all quadrants and would continue.

"After 2 or 3 more minutes of flight, I said we should turn back because the weather was too bad to continue. The pilot agreed and, almost immediately, saw powerlines in front of us. He applied power and aft cyclic to fly over the lines. Our air speed before this was approximately 90 knots. We went IFR and the pilot began a turn to the right while I monitored the gauges. Our angle of bank was approximately 20 degrees, air speed 65 knots and we were descending at 200 to 300 feet per minute.

"The pilot leveled the aircraft and I looked ahead and saw wires, at least three, directly in front of us. The pilot applied aft cyclic and we hit the wires in a nose high, right bank attitude. There were several bright flashes and crackling noises. The aircraft continued to fly straight and the pilot landed with power in an orchard approximately 1 minute after we hit the wires."

Findings: "Weather was a factor in this accident, in that the weather was reported better than was actually present at the time of the wire strike. The weather was reported as 500 feet agl en route and the aircraft went IFR at 250 feet agl.

"Crew error was also a factor, since the aircraft commander elected to continue on course after being advised that an aircraft approaching their location, flying southeast, had to reverse course because of weather.

"Training was a factor, in that the aircraft commander and pilot were both tactical instrument card holders and did not have the training or experience to proceed on their heading due to deteriorating weather."

Third indorsement: ". . . No weather report was obtained for the time of the accident, as required by AR 95–5, par. 11–12d(1) and par. 13–3c.

"Reference DA Form 2397–1, block 10: Damage to civilian powerline was not included.

"DA Form 2397–3 does not follow the format described in AR 95–5, par. 15–5.

"Reference DA Form 2397–8, block 5, on the pilot: The flying hour sum of blocks 5c, 5d, 5e and 5f approximately equals the pilot's total flying time, indicating the pilot logged no student pilot time (AR 95–5, par. 15–10(5)).

"Reference DA Form 2397–10: The 'needed' column is not filled in. The 'available' column is not filled in for blocks 1, 2 and 3. The information code

is not entered in blocks 2 and 3.

"DA Form 2397–16, block 11, is not in accordance with AR 95–5, par. 15–18(8).

"The commanding officer . . . did not indorse the report.

"Request the corrected report be returned to this headquarters . . ."

Fourth indorsement: ". . . Weather report is not included in this report because the weather officer at . . . said he had received no request to keep this data and it has been destroyed.

"Estimate [of damage to powerlines] is unavailable at this time.

"DA Form 2397, block 5, on the pilot does not indicate his student time, as his flight records were lost at one time and student time is no longer included in his records. This has been recorded on DA Form 2397–19. . . ."

DA Form 2397–19, block j, psychophysiological and environmental factors: ". . . the local flight surgeon felt he could not properly complete these forms due to the excessive delay of time between the accident and actual requirements to fill out these forms."

Letter of transmittal: ". . . The board did not release the aircraft commander or pilot for their postaccident checkrides, as they were already flying when first interviewed.

"Postaccident procedures were inadequate. Notification of an investigator for this board was too slow; i.e., the investigator was notified 2 days after the accident.

"If the investigator had been notified promptly, he could have obtained more facts at the scene of the accident and the aircraft would not have been moved from the scene before his arrival. The aviators would not have been flying again before he could interview them and the flight surgeon's report would have been filled out. . ."

No photographs were included in the reports for these two accidents. A notation in the report for the first accident stated: "A photographer was not available at the time of the accident." A notation in the report for the second accident stated: "Photographs were taken of the damaged aircraft in color slide form and cannot be locally processed to black and white prints. The color slides can be found in the . . . aviation safety office."

AR 95–5, chapter 9: "The success of any aircraft accident investigation depends upon its organization and a comprehensive preaccident plan. This is essential in order to effectively use available personnel and equipment to produce the best possible results. The scene of an accident can readily develop into one of complete confusion without proper planning and organization.

"A current preaccident plan will be developed and maintained for each operational Army airfield. This plan should be prepared by the aviation safety officer and, to be effective, must include but not be limited to the following:

"a. Crash alarm system.

"b. Crash rescue plan.

"c. Notification of board members who will investigate the accident, to include the flight surgeon. A duly appointed accident investigation board should be readily available as part of the preaccident plan. This board should include the most capable personnel available to the appointing authority. . . ."

In contrast to the investigations and reports of the previous two accidents, consider the following brief and excerpts from a report that is complete in every detail, well documented with evidence to support the findings and recommendations, and which leaves no unanswered questions.

Accident No. 3: An AH–1G pilot had hydraulic problems during an afternoon mission and landed.

ACCURATE AND THOROUGH?

His home airfield was notified and an LOH pilot, carrying a technical inspector, took off at 1740 to go to the downed pilot's aid.

Description: ". . . En route, the LOH pilot encountered light scattered rainshowers and low visibility in the rain. There were numerous cumulus buildups to the north and the wind was from the west. Shortly before he reached the destination area, visibility dropped to approximately one-half mile and it became necessary for him to follow the river to the stagefield where the AH–1 was located.

"The TI worked quickly on the Cobra, repairing the hydraulic leaks in approximately 15 to 20 minutes. While he was retorquing the lateral servo system to stop the leaks, the Cobra pilot, a UH–1H pilot who was air mission commander during earlier operations and the LOH pilot discussed the en route weather. The ceiling had gone to an estimated 600–1,000 feet at their location and the LOH pilot anticipated no problems on the return trip, stating that he thought the weather would be clear throughout their flight route.

"The AH–1 pilot was designated to lead, the LOH pilot, with no observer, was to fly number two and the UH–1 pilot was to fly trail. The TI returned in the UH–1. The flight of three took off at approximately 1845 on a heading of 120 degrees. Their initial cruising altitude was between 900 and 1,000 feet.

"After approximately 20 minutes of flight, light rainshowers were encountered, along with a decrease in flight visibility to between one-quarter and one-half mile. The UH–1 pilot suggested they turn back. The AH–1 pilot informed him they would be through the rain in a few minutes. At this point, he descended to between 300 and 500 feet. The other two aircraft followed and the visibility remained the same, at one-quarter to one-half mile.

"Encountering a lower cloud deck, the AH–1 pilot started a right 180-degree turn. During the turn, he entered the cloud, losing visual reference with the ground. He continued in the turn and descended in an attempt to pick up visual reference with the river. He leveled off between 150 and 200 feet on a heading of 330 degrees, with the river off to his right. His aircraft then broke out of the cloud and he sighted the river. By this time, it was well into dusk and he could only see the light and dark contrast between water and vegetation.

"The AH–1 pilot made a standard rate turn toward the light area that he concluded was the river. His heading was then 045 degrees and he estimated his air speed at 70 knots. He then leveled off, but was unable to see through the front plexiglass due to light rain. He could only see the river through the side of the cockpit.

"The helicopter struck a group of four trees, breaking them off between 60 and 65 feet above the ground. The pilot neutralized the controls in an attempt to stabilize the aircraft. He continued in a northeasterly direction for 160 feet, shearing a three-trunked tree at a height of approximately 45 feet. By this time, the left skid and left rocket pod separated and the nose cockpit was shattered. The helicopter struck another tree approximately 80 feet along the flight path at an altitude of 30 feet. It continued in a rapid descent and crashed into the river approximately 150 feet from the south shore.

"The accident occurred at approximately 1930. The LOH and UH–1 pilots had lost contact with each other and were unaware of the accident until after 2000, when they landed for fuel. The UH–1 pilot circled the area where initial visual contact was lost, flashing his landing light in an attempt to locate the Cobra and LOH. He finally broke station due to the weather and low fuel. The LOH pilot flew straight ahead in a gradual descent and finally emerged from the weather. He landed near a village until the weather broke enough for him to get to the refueling point where the UH–1 landed.

"When the AH–1 impacted in the river, the cockpit immediately started to fill with water and the aircraft began to roll to the right as it sank. It continued to roll upside down and the pilot could feel himself restrained by his harness and seatbelt. As he was rolling, he attempted several times to open the cockpit, but the latch was stuck. He got his right leg up and managed to kick it open (at no time did he attempt to use the emergency release). As soon as the canopy opened, he released his seatbelt. By this time, the aircraft had rolled to the upright position and he floated to the surface. Neither the pilot nor the copilot were wearing their protective armor plates.

"When he reached the surface, the pilot removed his helmet and clung to the tail boom, catching his breath, while searching for the copilot. The helicopter

sank rapidly and he swam for the south bank. Reaching shore, he felt unsafe with a rapidly growing crowd and elected to float further downstream. He floated for approximately 2 hours, until he became extremely cold and tired.

"Swimming to shore, he found a flat-bottomed skiff, untied it, climbed in and continued downstream for another hour and a half. At this point, the skiff became entangled in a fishing net. The fisherman who owned the net took the pilot to the home of a villager who notified a military outpost. The time was approximately 2300. It was not until midmorning of the following day that word reached the board about the pilot's survival. The copilot's body was recovered from the submerged aircraft by divers the next day."

Investigation: ". . . At 0300 the morning after the accident the board president was notified of his designation as president of a board consisting of himself, two other aviators, a flight surgeon and a recorder. The board, along with the unit safety officer, left for the crash site at 0700.

"An aerial recon of the site and flight path confirmed initial reports that the aircraft had crashed in the river. There were no major components or large portions of the wreckage visible from the air. The apparent flight path was 045 degrees and the Cobra had cut a clearly defined swath through the trees. No oil slick was visible on the river.

"We landed and walked to the area of severed treetops. When we got there, our suspicions were confirmed, in that no major components were found. Those pieces of debris that were found had been disturbed in varying degrees by the villagers. The first four trees that were hit were clustered together and broken at a height of 60-65 feet. The board determined they were severed by a fuselage strike and believe the copilot sustained his injuries at this point.

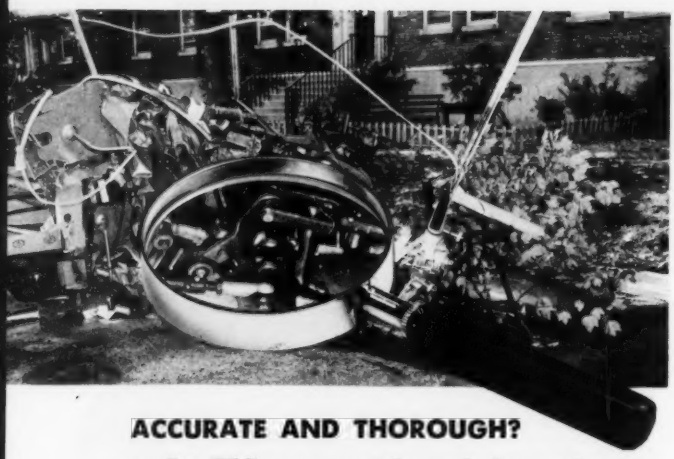
"The diameters of the trees varied from 12 to 15 inches at the bases. The front cockpit and canopy received the brunt of the impact, shattering the plexiglass and framework. Canopy parts could be seen in the tops of the trees adjacent to the flight path.

"The copilot's chestplate and left skid crosstube crashed through the roof of a hut approximately 125 feet forward of initial impact. The left skid was found 90 feet from initial impact, along with the left rocket pod. The next tree struck was a three-trunked tree that was 24 inches in diameter at the base. Finally, the helicopter severed an 8-inch diameter tree before going into the water.

"Debris was scattered throughout the immediate area and the villagers were asked to return all parts to us. A helmet and logbook were returned. . . . It was later determined that the helmet belonged to the

Arrows show flight path and initial tree strikes

Three-trunked tree, showing severed trunks and flight path



ACCURATE AND THOROUGH?

copilot. While we were at the crash site, word was received that the pilot had been found unhurt and was available for a statement. We gathered all the available wreckage, except for the rocket pod, and took off for our home base. Enroute, we arranged for EOD to destroy the numerous rockets strewn throughout the crash area and the ones remaining in the rocket pod.

"The three pilots and the TI were interviewed separately and their observations recorded on tape before the board. The board met again at 1300 and specific duties and areas of responsibility were assigned."

Witness investigations: "Village witnesses from the crash site told us it had been raining and they heard loud explosive noises before hearing something splash in the water.

"Weather between the home airfield and the area from which the three aircraft departed was observed to be marginal, with low visibility encountered in rainshowers. At one point, it became necessary for the LOH pilot to use the river as a reference to find the field where the downed Cobra was located.

"Prior to the flight's takeoff, the en route weather picture was discussed, with the conclusion made that the rainshowers would move out of the route of flight and not present any major problem. Inadvertent IFR procedures were not discussed among the pilots. Neither of two available radar flight following facilities was contacted for flight following, nor was a weather ship dispatched to observe the local weather. The aircraft were designated as chalk 1, 2 and 3, with the AH–1G as lead ship. Estimates of the ceiling ranged from a low of 600 feet (UH–1 pilot) to a high of 1,000 feet (AH–1 pilot). The AH–1 pilot set his altimeter at 40 feet prior to takeoff. The field elevation where they were located is 10 feet.

"It was drizzling at takeoff and heavy rains were encountered after approximately 20 minutes of flight. The two following pilots stated that the initial cruising altitude was probably 500 feet, while the lead pilot estimated it at 1,000 feet. No one was quite sure.

"Visibility out of rainshowers was forecast to be 7 miles. The pilots estimated that visibility dropped from 1 mile in light rain to one-quarter mile in heavy rain. No clear-cut decision was made to turn back when the visibility and ceiling began to worsen. Each pilot acted on his own. The AH–1 pilot started a right 180-degree descending turn, the LOH pilot continued ahead in a gradual descent and the UH–1 pilot orbited the area in an attempt to locate the other two. . . . The AH–1 pilot said he never got below 150 feet indicated and that his angle of bank during the turn toward the river was between 5 degrees and 10 degrees. When he struck the trees, he was, to the best of his knowledge, straight and level at 70 knots IAS.

"At initial impact, both armor chestplates left the aircraft, one crashing through the roof of a hut. The pilot had stored his chestplate on the left side, between the seat armor and plexiglass. The copilot had stored his on the right side, between the seat armor and plexiglass. The pilot had no opportunity to prepare for impact in the water, as he was attempting to stabilize the aircraft while it crashed through the treetops."

Airframe: "The aircraft was never recovered from the river because adequate equipment was unavailable. The following airframe damage estimates were obtained by divers. All plexiglass was broken from the canopy forward of the pilot's door, but some of the framework was still intact around the pilot's compartment; the nose was almost completely destroyed and the gun turret was missing; the bottom of the Cobra was badly damaged, with numerous rips, tears and skin wrinkles evident; the right rocket pod was still attached to the aircraft, but the right wing had a 6- to 10-inch rip in it next to the fuselage; the left wing appeared undamaged; the outer portions of the synchronized elevators were sheared off and the remaining portions badly damaged; the tail boom appeared to be intact from the forward attaching point back 10 to 12 feet; and the main transmission cowling doors had popped open. These observations were made almost entirely by touch because visibility was extremely limited in the muddy water. The aircraft was upside down and had partially settled into the mud."

Systems: "Examination of fuel, oil, hydraulics, electrical, control stability augmentation and other systems was impossible because the aircraft was not recovered. Leakage in the lines of the lateral servo system had been experienced earlier in the afternoon. The technical inspector was dispatched and the leaks repaired. The pilot stated there were no further hydraulic problems."

Powerplant: "Examination could not be per-

formed, but the pilot stated that the engine functioned normally throughout the day."

Rotors: "The main rotor blades were buried in river-bottom mud and observation by the divers was impossible. . . ."

Communications: "The LOH pilot stated he could receive, but not transmit, shortly after entering the heavy rain. After landing, he plugged into the copilot's line and was able to establish contact with the pilot of the UH–1."

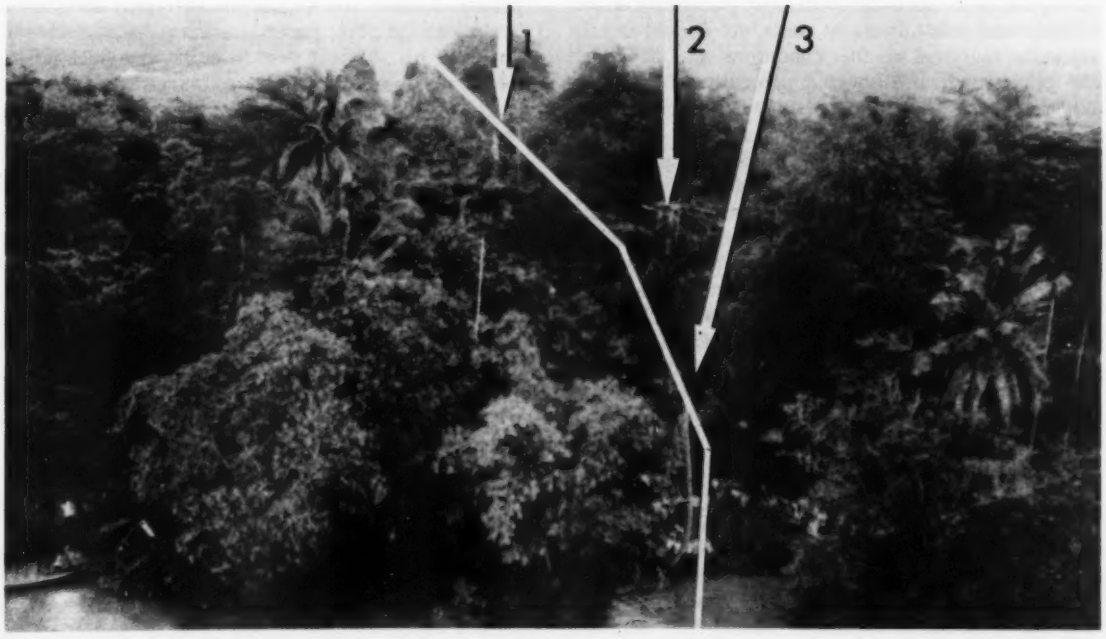
Personnel records: "Research of flight records revealed nothing unusual about the AH–1 pilot's flight experience. He had nearly 900 rotary wing flying hours and had flown more than 600 hours in AH–1Gs. He had completed the AH–1G instructor pilot course the previous month and all 90-day standardization rides had been completed with no adverse comments. His postaccident checkride was successfully completed the day after his accident. Aside from a slight nervousness on his part, the ride was satisfactory."

Aircraft records: "A thorough examination of aircraft historical records, flight logbook and maintenance records was performed by the aviation maintenance officer. In general, the historical records and weight and balance forms were in proper order and well maintained. The Cobra had an outstanding flying record up to the time of the accident. It had flown a total of 3,213 hours, with no previous major damage. Two hard landings resulting in skid changes were the only prior damage noted. Weight and balance computations performed by the aviation maintenance officer showed the aircraft was operated within c.g. limitations and under maximum gross weight at the time of the accident.

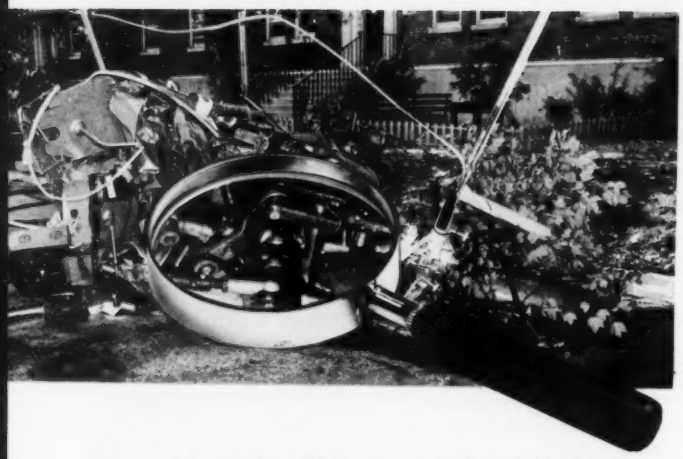
"There were, however, discrepancies in the following areas which, had they been eliminated or complied with, might have prevented the accident. The requirement for retorquing the lateral servo system by the TI to stop hydraulic leaks indicated that maintenance performed on that system 2 days before the accident resulted in improper torque. This caused the aircraft to remain out after the normal daylight release time.

"The pilot's attitude indicator had been carried as inoperative for 13 days prior to the accident. This placed the aircraft in a circled red X status for IFR and night operations. This was obviously not complied with. In addition, the improved attitude indicator system MWO (55–1520–221–30/19) had not been complied with.

"An overdue PMD inspection was not signed off, automatically grounding the aircraft.



Arrow 1 shows initial tree strikes, arrow 2 shows three-trunked tree and arrow 3 shows final tree strike before Cobra plunged into river



the scene of an accident can readily develop into one of complete confusion without proper planning and organization

"An engine flush was overdue. This is also a grounding condition.

"There were no MOCs written up or signed off for the hydraulic system maintenance 2 days before the accident. This indicates the possibility that no one checked for leaks. . . ."

Analysis: "The early warning of improper procedures and difficulties leading to the accident occurred when the pilot elected to take off at dusk in an aircraft that contained numerous grounding conditions. . . . The pilot was aware of the distinct possibility of low ceilings and rainshowers en route, yet elected to take off under marginal weather conditions. . . . None of the pilots involved discussed procedures in case inadvertent IFR was encountered during the return flight.

"Prior to takeoff, the AH–1 pilot erroneously set his altimeter at 40 feet, causing him to be 30 feet lower than indicated in flight. He did not recall whether the altimeter was set prior to engine start or while the rotor blades were turning.

"The AH–1 pilot was designated as lead aircraft in a flight of three, but was not flight lead and made no decisions for the flight. No one assumed this responsibility. Upon encountering decreased visibility in rain and low ceilings, the AH–1 pilot elected to continue on course and descend, rather than turn back. Visibility had dropped to one-quarter mile and the flight had descended to approximately 300 feet, possibly lower.

"Encountering IFR conditions, the pilot decided to turn back. The board believes the AH–1G was excessively low in altitude at that point, while visibility was extremely restricted due to rain, darkness, low clouds and the additional restrictive element of a tinted windshield.

"The pilot continued to descend while turning 180 degrees, thereby placing him at a critically low altitude, even for the flat land over which he was flying. While turning toward the river he struck the trees and finally came to rest in the river. The pilot was able to maintain adequate control throughout the crash sequence and successfully exit while under water. He did not attempt to use the emergency canopy release, stating it never entered his mind to do so. Impact caused him to slide under his seatbelt, increasing his ability to lift his leg to a position that enabled him to kick the door open. While he had no opportunity to prepare himself for impact, he sustained only minor bruises and a slight facial laceration. Because he did not wear his survival vest (it was stored behind the pilot's seat), he was unable to signal the rescue aircraft dispatched to the area. His excellent physical condition and swimming ability enabled him to survive by floating down the river.

"The cause of the copilot's death was found to be drowning, secondary to unconsciousness at the time of the crash."

Findings: "The aircraft was restricted from IFR conditions and night operations due to an inoperative attitude indicator.

"The aircraft had been flying throughout the day under two red X conditions; PMD overdue and engine flush overdue.

"The pilot used poor judgment in taking off during a timeframe that would put him in night flight conditions.

"The pilot used poor judgment in taking off under marginal weather conditions.

"The pilot demonstrated poor judgment by electing to penetrate further into IFR conditions.

"The pilot demonstrated excellent reflexes and control touch by maintaining positive control of the aircraft throughout the crash sequence.

"The pilot was remiss in not wearing his survival vest, thereby rendering timely rescue impossible.

"The pilot's excellent physical condition contributed significantly to his surviving the crash."

Recommendations: "That commanders at all echelons discourage pilots from flying in marginal weather conditions for the sole purpose of returning to home base.

"That the practice of flights of two or more aircraft acting as their own flight following be discontinued and that available flight following facilities be used.

"That positive inadvertent IFR procedures be incorporated into unit SOPs. These should include headings, altitudes, frequencies, turning procedures and aircraft separation.

"That increased emphasis be placed on the instrument flight training program.

"That increased supervision to assure proper maintenance procedures are complied with be implemented.

"That increased command emphasis be placed on flight safety related modification work orders.

"More aviator orientation toward mechanical serviceability of aircraft and aircraft flight records.

"Local regulations contain no reference to required equipment for IFR and night operations. Recommend appropriate changes be made, with reference to AR 95–1, par. 3–5a(4) and b(3), Required Equipment.

"That 90-day standardization checkrides include the use and wear of survival equipment and emergency exit procedures.

"That operations inprocessing checklist for newly assigned aviators include fitting of helmet by unit flight surgeon and proper procedures for maintenance and wear of helmet.

"That this accident be discussed with all pilots."

Reviewing official: "I concur with the findings of the board. This unit is implementing an instrument training program. Minimal training will include proper voice procedures to contact control agencies and pilot proficiency in accomplishing ADF and GCA approaches.

"All personnel concerned have been briefed on the hazards of flying aircraft that have grounding conditions present.

"All aviators within the unit have been briefed on the proper procedures for exiting inadvertent IMC. Troop SOPs have been reviewed and briefings presented to all aviators. . . . Operations checklist for inprocessing newly arrived personnel will include the proper fitting and care of the flight helmet by the flight surgeon."

Fifth indorsement: "Concur with the findings and recommendations of the accident investigation board, with the following amendments:

"Findings—add supervisory—air mission commander did not exercise proper degree of supervision in that he allowed the flight to take off into marginal weather conditions with the lead aircraft having an inoperable attitude indicator.

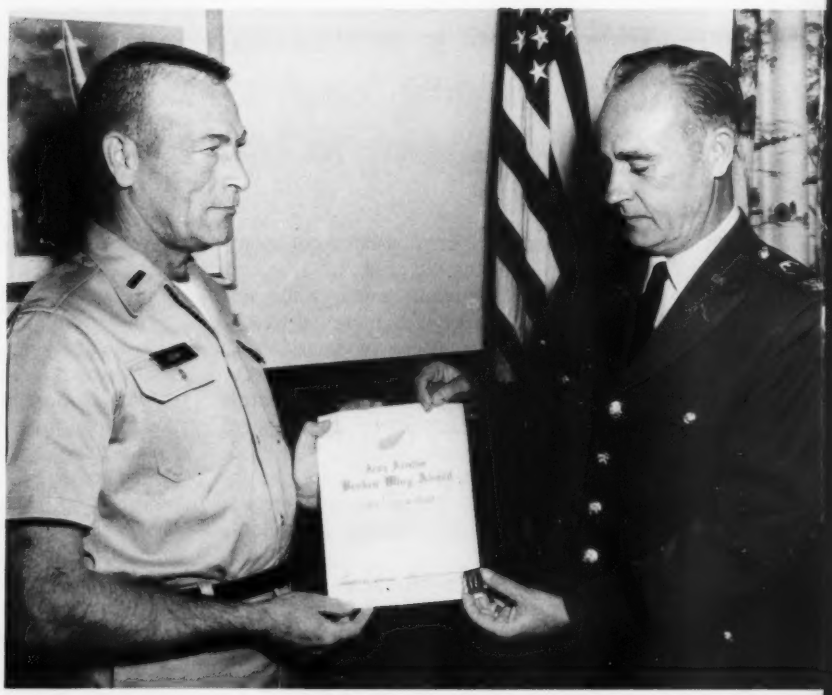
"Recommendations—AR 95–1 contains reference to required equipment for IFR and night operations. Supplemental regulations do not repeat references from basic regulations. Rather, they are used to outline additional requirements or guidance."

Approving authority: "The findings and recommendations of the accident investigation board, as amended by the fifth indorsement, are approved. Corrective actions are adequate."

Despite many adverse circumstances and conditions, the members of the board which investigated and reported this accident can rest assured that they have made a substantial contribution to the aviation accident prevention program because they were *prepared* and because they were *accurate and thorough* in their conduct of the investigation and their complete report.

Pat Thompson

ARMY AVIATION



REDSTONE ARSENAL, ALABAMA—CW4 Richard C. Grant (left) received the Broken Wing Award from COL Alva J. Forsythe. Twice during his flying career, Grant had engine failures and landed successfully. The second engine failure was the one in which he earned the Broken Wing Award. Approximately 1 hour after takeoff in a UH-1H, he was flying at 2,500 feet when the engine stopped. He autorotated and landed in a field near Charlottesville, Virginia. A veteran of 23 years service, Grant has been flying for the last 12 years and has experienced some close calls. While there may be an element of luck involved, Grant thinks that studying emergency procedures and accident prevention techniques has been the biggest factor in his safe flying career.

CAMP MURRAY, TACOMA, WASHINGTON—CPT James M. Hodgeboom, 540th Aviation Company, was presented the Broken Wing Award by MG Howard D. McGee (left), Adjutant General of the Washington Army National Guard. CPT Pat Ferguson and SP5 Don W. Grogan, who received letters of commendation from the Washington Army National Guard for their actions during the emergency, look on. CPT Hodgeboom was on a UH-1D service mission when his engine failed in cruise flight at 3,200 feet over mountainous terrain. First suspecting a high-side governor failure, he applied collective and rolled off throttle. The fire warning light came on and smoke entered the cockpit through the bleed-air heater vents. The rpm dropped to 6100 and CPT Hodgeboom autorotated in semidarkness to the 50-by-100-foot portion of a logging road half way up the side of a 6,000-foot mountain. CPT Hodgeboom was the ninth Army National Guard aviator to receive this award during the past 3 years.

BROKEN WING AWARD

WHAT WAS the origin of the Broken Wing Award? Who is eligible? What are award criteria? Can the lapel pin be worn on military clothing? How many aviators, active Army and National Guard, have received the award? How many are presented each month? These are some of the many inquiries USAAAVS constantly receives from the field. This article is designed to provide the answers.

The idea for the Broken Wing Award was conceived by the U. S. Army Aviation Center Safety Office, in conjunction with the Director of Rotary Wing Training at the U. S. Army Aviation School, Ft. Rucker, AL. It was originally established as the Commandant's Broken Wing Safety Award by USAAVNC Regulation Number 385–14, dated 22 June 1967, to recognize aviators of the USAAVNC, USAAVNS and Ft. Rucker tenant activities who demonstrated exceptional skill in recovering aircraft from in-flight emergencies, other than those which were self-induced.

This photograph of a crippled O-1G clearly illustrates why CPT Richard J. Wright was given the Broken Wing Award. During a visual reconnaissance mission at 6,000 feet over mountainous terrain in Vietnam, CPT Wright's aircraft was hit by 37 mm enemy fire, destroying the major portion of the left horizontal stabilizer and damaging the rest of the empennage. Though his controls were unresponsive and the aircraft hard to handle, CPT Wright landed on a rotary wing airstrip with no further damage.

Due to the expressed interest of the Director of Army Aviation to initiate the award on a worldwide basis, the U. S. Army Agency for Aviation Safety (USAAAVS), formerly USABAAR, conducted a staff study during April 1968 to determine the means to best implement the award on a worldwide basis. The conclusions and recommendations of the study were accepted. The award was established and the criteria incorporated in AR 385–10 on 16 September 1968, with USAAAVS designated the proponent agency. This regulation outlines the criteria and information required for nominations of individuals for the award. Its provisions are applicable to all military, including National Guard and Reserve, and civilian personnel authorized to fly Army aircraft. The aircraft must be owned or leased by the Army at the time of the emergency.

All nominations for the award should be submitted to the Commanding Officer, United States Army Agency for Aviation Safety, ATTN: Chairman, Broken Wing Award Committee, Ft. Rucker, AL 36360. Nominations may be made by any person having knowledge of the event and should be forwarded without indorsements. For information requirements, refer to paragraphs d(1)(a) through d(1)(r), chapter 7, AR 385–10. Particular attention should be given paragraph d(1)(n). This paragraph should contain an *exact narrative* of the actions taken by the aviator to cope with the emergency. In many instances, persons making nominations fail to comply with paragraph d(1)(r) which re-

BROKEN WING

quires that a copy of the crash facts message be submitted with the nomination.

The Broken Wing Aviation Safety Award consists of a certificate signed by the Director of Army Aviation and the Commanding Officer of USAAAVS, plus the broken wing lapel pin. In accordance with paragraph 130, C 19, AR 675–1, the lapel pin may be worn *only on civilian clothing.*

Due to many questions concerning disapproved nominations, a committee consisting of personnel from Class II activities and the

FORT WOLTERS, TEXAS — Army Aviation's Broken Wing Safety Award was awarded CWO Daniel E. Leyk (left), son of Mr. and Mrs. Daniel E. Leyk, 1708 Michigan Avenue SE, St. Cloud, Minnesota. His flight commander, CPT Larry Mullendore (right), presented the award. Leyk was cited for extraordinary skill, judgment and technique when he experienced an emergency while flying a CH-47A training mission in Vietnam. He was able to land without damage. Leyk served with the 242nd Aviation Company in Vietnam. A 1967 graduate of Technical High School, St. Cloud, he has been in the Army since April 1968.

REDSTONE ARSENAL, AL.—CW3 James R. Anderson (left) and CW3 Charles L. Williams Jr. (right) were awarded the Broken Wing Award by Colonel A. J. Forsythe (center), director, Redstone Arsenal Support Activity, during a presentation ceremony. These aviators were on a VC-6A service mission when the landing gear failed to fully retract after takeoff. They orbited the area until daylight. All attempts to lower and retract the gear were unsuccessful. CW3 Anderson removed the floorboards and discovered that the landing gear torque tube was sheared. While he held the ratchet assembly in place, CW3 Williams manually lowered the left gear and landed without damage.

U.S. Army Aviation School established a more positive approval and disapproval criteria for the award. These were approved by the Director of Army Aviation during January 1971. These are:

APPROVAL CRITERIA

1. All aircraft saves due to emergencies resulting from: (a) complete power loss, (b) complete electrical failure during IMC or night flight, (c) hydraulic failure, (d) partial loss of control capability, (e) loss of tail rotor, or (f) landing gear malfunction.

2. In the above emergencies, when lives are saved or there is minimal damage due to extraordinary aviator skill, and the terrain could have precluded a successful outcome.

3. Loss of an engine in a multiengine aircraft, if complicated by other conditions, such as weather, load or type and condition of available landing site.

4. Only the skill and judgment exercised by the aviator at the time of the emergency will be considered. The age, past experience, total flying time, years rated and the rationale that "an experienced aviator should be able to cope with the situation" shall not be a factor in giving the award.

DISAPPROVAL CRITERIA

1. Emergency is self-induced.

2. During a simulated emergency, an emergency actually occurs, but no additional skill is required to successfully land.

3. Violation of regulations, unless required by the mission.

4. An emergency never existed.

5. In the board's opinion, where lack of discipline or aviator judgment offsets the emergency.

6. When the emergency occurs, the aircraft is at a hover and no extraordinary circumstances are present to preclude a successful landing.

7. When the emergency occurs, the aircraft is within reach of a good landing area or prepared airfield and no extraordinary circumstances are present.

Before USAAAVS assumed proponency for the award, the U. S. Army Aviation School presented the Broken Wing Award to 26 aviators during 1967 and 1968. Since USAAAVS became the proponent agency and the award was implemented worldwide, the board has acted on 434 nominations during calendar years 1969, 1970 and 1971. Of these, 204 aviators received the award. Nine of the aviators were members of Army National Guard units. An average of nine awards was presented monthly during 1971. A listing of aviators who have received the award since its implementation follows. Asterisks denote ARNG aviators.

Calendar Years 1967 and 1968

CPT Lonnie S. Beasley
David E. Boutwell, DAC
CW2 Maurice N. Bradford
CPT Peter M. Candler
CWO Angus Desveaux
CW2 Vincent R. Foulkes
CWO Jay E. Gillman
CWO J. Hamilton
CW3 Raymond L. Henry Sr.
CW2 Rodney G. Hillard
CW2 Kenneth T. Kendrick
CW2 Gilbert C. Lattimer
CWO George B. Lesnick
CW3 Duane S. Miner
LTC Atsuski A. Miyamoto
CW3 George C. Parker
WOC George A. Rehmus
CW2 Joseph F. Salomone
CW2 Richard A. Sloan
WOC Russell P. Smith
CW3 Dale L. Stockwell
Edward B. Subowsty, DAC
LTC Samuel E. Tillery Jr.
CW2 Ralph A. Valentine
CW3 Freddie L. Waters
CWO Richard J. Whatley

Calendar Year 1969

CPT Larry N. Ammons
CW2 Norman D. Auten
CW2 Joe R. Boswell
WO1 David M. Bortscheller
CPT Alvin V. Boykin III
WO1 Alexander P. Cameron
CW2 Hal E. Carriger
CW2 Richard E. Day
WO1 Dana DeWoody
WO1 Donald R. Doane
WO1 Donald A. Elson
CW2 Thomas W. Elwell
CW3 William G. Everhart
WO1 Edward F. Ferguson
CW2 Edward J. Franklin
WO1 David F. Freeberg
CW3 Frank Freitas
CPT Alan J. Fry
CW2 Robert L. Gayton
CW2 Michael E. Gilsdorf
WO1 David R. Gour
CW2 Michael W. Hamblin
CW2 John M. Hammons
WO1 James C. Hewitt
CW2 Mark H. How
WO1 David R. Jackson
1LT Charles W. Kirby
CW2 William W. Lindner
*CW3 Henry S. Luchner
CW2 John N. McFarlane
1LT George W. McKenna
CW2 James B. Michie
*CW2 Paul R. Mongerson
LTC Vernon G. Munson
WO1 Michael A. Nicholaou
CPT Edmond A. Paquette
*CW2 Julius D. Porter
CPT Marco A. Principio
CW3 Royce D. Raley
CW2 Thomas A. Rey
CW2 Harry M. Rusham
WO1 Marshall A. Scott
1LT James J. Sheehy Jr.
CPT Richard L. Stamm
Louis G. Starks, DAC
WO1 Kit C. Stephens
WO1 Donald G. Study
WO1 Donald L. Wann
WO1 Gerry L. West
CW2 Kenneth R. Whitley

Calendar Year 1970

WO1 Gerald L. Anderson
WO1 Robert E. Barrett
CW2 James E. Bias

BROKEN WING

WO1 Gordon L. Cockrell
CW4 Harold W. Davis
MAJ Howard D. Deane
WO1 Roy A. Dowd
WO1 Walter H. Fugler
WO1 Philip H. Garvey
CW2 Robert W. Glomb
CW2 Robert E. Hammond
CW2 William S. Hesse
CW2 David F. Hill
CW2 Ronald G. Holbert
WO1 Michael D. Holder
CW2 James A. Jennings
1LT Donald B. Kaveny
1LT William R. Kruse
1LT Elmer L. LaGrelius
WO1 Jack A. Lease
CW2 John T. Marqua
WO1 Donald E. Marsh
WO1 Joel L. Morris
CPT Kendall Norman
WO1 Donn D. Olson
WO1 Thomas E. O'Neil
CW2 James J. Pecorelli
WO1 Michael E. Rigney
CW2 Jack R. Roberts
1LT Arnold H. Sampson
2LT Steven J. Schmidt
WO1 Albert C. Schonert
WO1 Andrew G. Schultz
CPT James C. Smallwood
1LT Harry K. Staub
WO1 Ronald E. Stokes
WO1 David A. Trujillo
CPT Robert B. Tucker
2LT Richard A. Walton
CW2 James V. Weatherill
CW2 Donald R. Worz
*CW2 Constantinos G. Zagkos

Calendar Year 1971

1LT Thomas S. Allen
WO1 Allen Alexander
CW2 Wesley O. Anderson
*1LT James L. Arscott
CW3 Brian R. Arsenault
CPT Rene I. Beauchamp
CPT Raymond L. Beauregard
CW2 William H. Bernard
CPT Hansford L. Bohanon
CPT William E. Bolling
CW2 Drew T. Boudrieau
CPT Roger D. Bowers
WO1 Jeffrey L. Brown
CW2 Robert E. Browning
CPT Chester E. Buchanan
CPT William E. Bunton
CW2 William A. Burleigh
CW2 Richard R. Bush
CW2 Gary M. Butler
WO1 Gary R. Cantrell
MAJ William F. Carroll
CPT Taylor L. Conley
CW2 Gregory L. Cook
WO1 Gerard G. Cote
CW3 James C. Cowart
1LT Donald E. Curry
CW2 Glenn T. Davis
WO1 Ross E. Davis
CPT Reginald E. Deal
CW2 Leslee E. Digman
CPT Dannie L. Dillard
CW2 Joseph Dobek
CPT Dennis A. Drake
CW4 Thomas H. Dunaway
CW2 William H. Elliott
WO1 Hector A. Freixa
CW2 Murl E. Geary
CPT Lawrence J. Gilbert
CW2 James T. Godwin
2LT Richard A. Good
CW4 Richard C. Grant
CW3 Kenneth W. Green
CPT David R. Greer
Gordon R. Griffith, DAC
WO1 Daniel Grossman
WO1 Wilbern C. Guthrie
CW4 Robert H. Hardwick
CW2 Thomas B. Hardy
CPT David E. Hays
CPT Gerald W. Hendley
CPT Donald E. Henry
CW2 Lonnie J. Hight
*CPT James M. Hodgeboom
CW2 William F. Jernigan
LTC Harold L. Johnson
CW2 James H. Johnson
LTC John A. Johnston
1LT Thomas P. Keating
CW2 Bobby N. Keller
2LT William F. Korfhage
WO1 William A. Landrum
CW2 Daniel E. Leyk
*CW3 Henry S. Luchner
WO1 Richard C. Lukens
CPT John P. Lutz
CW2 Barry L. Martens
1LT Michael D. Martin
WO1 Robert N. McAdams
1LT Mackey J. McDonald
CPT Robert N. McInnis
WO1 James W. McKnight
*CW2 Billy H. Miller
CPT Ronald L. Miller
CW2 James T. Miller
1LT William J. Mitchell
CPT Sidney H. Morrow
CPT Michael A. Nelson
WO1 Albert G. Olbeter
CW2 Rodney L. Orton
CW2 Mark A. Panageotes
Gilbert N. Parkinson, DAC
WO1 Thomas E. Paul
CPT Arthur E. Pekarek Jr.
CPT Bartholomew D. Picasso
CPT David G. Pipes
CPT David A. Rajala
CW2 Charles J. Ray
WO1 Paul L. Reed
CW2 Donald J. Reese
CPT Gordon W. Rogers
CW2 Cy A. Russum
CW2 Robert E. Sanders
CPT Peter A. Schobert
CW2 Leslie E. Scott
WO1 William L. Shillito
WO1 David M. Shinn
CW2 John C. Staton
CPT Charles R. Stutzman
CPT William T. Sweeney
WOC William K. Sweet
CPT John W. Swenson
WO1 Harold M. Thomas
CPT James E. Thompson
CPT Richard P. Tifft
*LTC Layton E. Timmons
CPT Fred H. Van Peer
CPT Ralph S. Wallace
CW3 Frank L. Wendt
CW2 John C. White
WO1 Charles M. Whittenton Jr.
CW2 Christopher N. Wickland
CPT Richard J. Wright

PEARL'S personal equipment and rescue/survival lowdown

It has been brought to our attention by USAARL that polycarbonate visors are adversely affected by certain organic solvents. This adverse effect or reaction negates the protection normally afforded by the visor. If any signs of cracks, crazing, blurring or dulling appear, the visor should be replaced.

Care must be taken in cleaning the polycarbonate visor in order to maintain its protective ability. When

continued on page 63

CRASHWORTHY TROOP SEAT DESIGNS

adapted from preliminary draft of USAAAVS Technical Report 72-5, "Proposal for a Forward or Rearward-Faced, Cable-Supported, 'Load-Limited' Troop Seat for UTTAS"

IN MANY INSTANCES, crews and troops aboard aircraft do not live through survivable accidents. One of the primary objectives of aviation safety is to increase occupants' chances of surviving survivable accidents. Not only is personal safety of paramount concern—the integrity of combat units must be preserved. To accomplish missions, combat soldiers must survive crashes and *remain uninjured* if their units are to maintain maximum effectiveness.

A recent USAAAVS study revealed that 93.5 percent of all accidents studied could be classified "survivable," yet 39.5 percent of all accident fatalities occurred in these accidents. Further, nearly three-fourths of the fatalities (72.5 percent) were passengers, crew chiefs or gunners.

Although installation of energy-absorbing mechanisms for pilots' seats has long been recognized as a requirement to reduce or eliminate injuries, other crew members and passengers have not been accorded the same consideration. Current Army aircraft seats for other crew members and passengers offer little in the way of crash protection.

A new Army troop-carrying aircraft, the UTTAS, is now taking shape on the drawing boards and the time is ripe to afford adequate protection for all occupants. In an effort to promote the development of more crashworthy troop seats, USAAAVS has worked closely with other U.S. Army Aviation Center

Joseph L. Haley Jr.
Aeronautical Engineer
Technical Research and Engineering Dept.
USAAAVS

organizations and arrived at some design guidelines to assist in developing crashworthy troop seats for the UTTAS.

In the course of selecting troop seats and restraint harnesses for further development for use in UTTAS, USAAAVS evaluated several variations of troop seats that face forward, rearward and sideward against six operational and crashworthy factors: (1) the degree of restraint afforded, (2) the probability that seat occupants would not suffer concussions, (3) the occupant's ease of getting into and out of the seat, (4) the stowage space required for the seat when not in use and (5) the weight per seat and forward visibility potential.

A rearward-facing troop seat mounted to ceiling and floor, incorporating a single diagonal shoulder strap and stowed on the ceiling, offered the most advantages in terms of the factors rated. USAAAVS also endorses the same type of troop seat facing forward. It is worth noting that, regardless of the direction the seat faces, seats mounted only to the floor rated lowest in the evaluation because of the low degree of restraint afforded and the higher probability of concussion. Designs which did not include shoulder harness also rated poorly in these two areas. Sideward-facing seats were not endorsed because they provide the poorest longitudinal-impact protection. USAAAVS, together with U. S. Army Combat De-

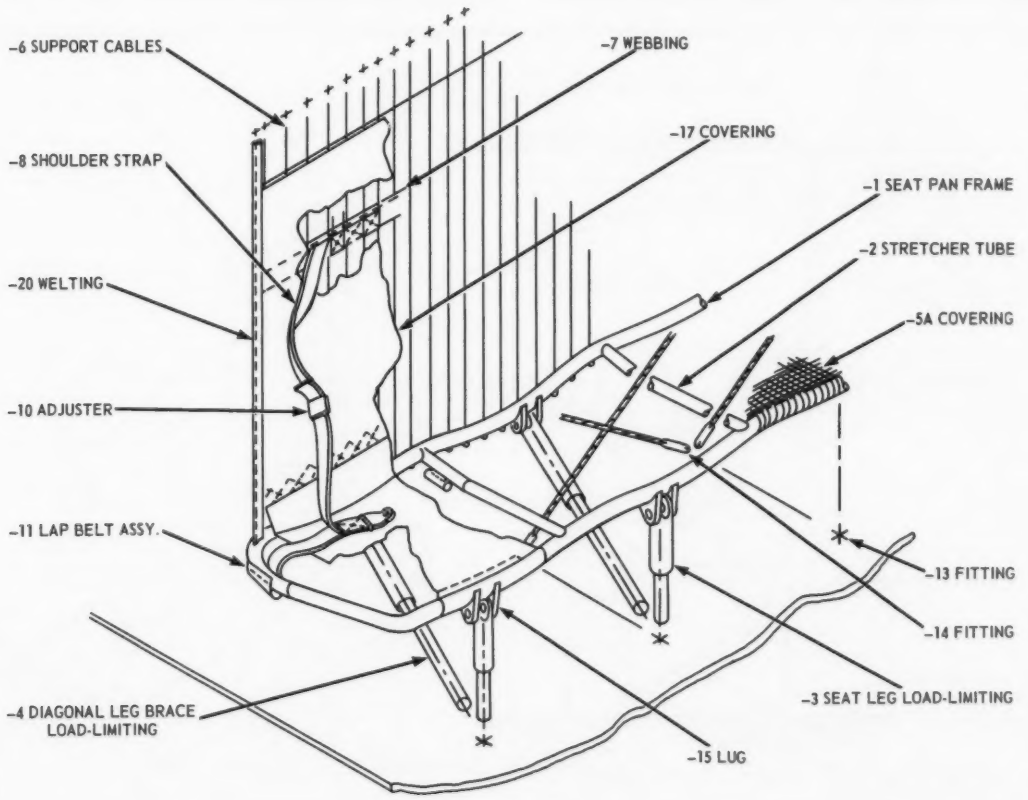


FIGURE 1
Rear-Faced, Four-Place Troop Seat

UTTAS TROOP SEAT DESIGNS

velopments Command Infantry Agency, U. S. Army Combat Developments Command Aviation Agency, Human Resources Research Organization, U. S. Army Aeromedical Research Laboratory and U. S. Army Aviation Test Board, agreed during May 1971 to oppose the installation of sideward-facing seats in the UTTAS because of the operational and crashworthy problems associated with this type of seat.

The design of seats does not stop with configurations. There are also desirable materials and special features to be considered. Controlled deformation of seat structures can reduce seat tiedown loads, as well as g forces imposed on occupants during crashes. Metals with inherent plasticity should be used to the maximum practical extent to provide means for the absorption of as much energy as possible. Other load-limiting (load-limiting refers to a device or material that limits the load in a structure to a pre-selected value) methods, such as separate devices, are also possibilities for troop seat designs. Load-limiting techniques used along all three axes can increase human tolerance to crash loads and reduce seat weight if these concepts are judiciously applied.

Seats should be attached to the ceiling, if possible, so that downward inertial loads will be distributed to the ceiling. The structural strength of the UTTAS ceiling will probably be more than adequate to sustain these loads, because it is designed to sustain rollover and litter-support loads. Ceiling mounts not only reduce floor loads for forward crash forces, but also reduce vertical g loading on seat occupants.

Where ceiling support seats are used, a floor support is also needed to give seat pans adequate rigidity. Floor supports must contain vertical load-limiting devices to prevent personnel injuries which result from upward buckling of floors.

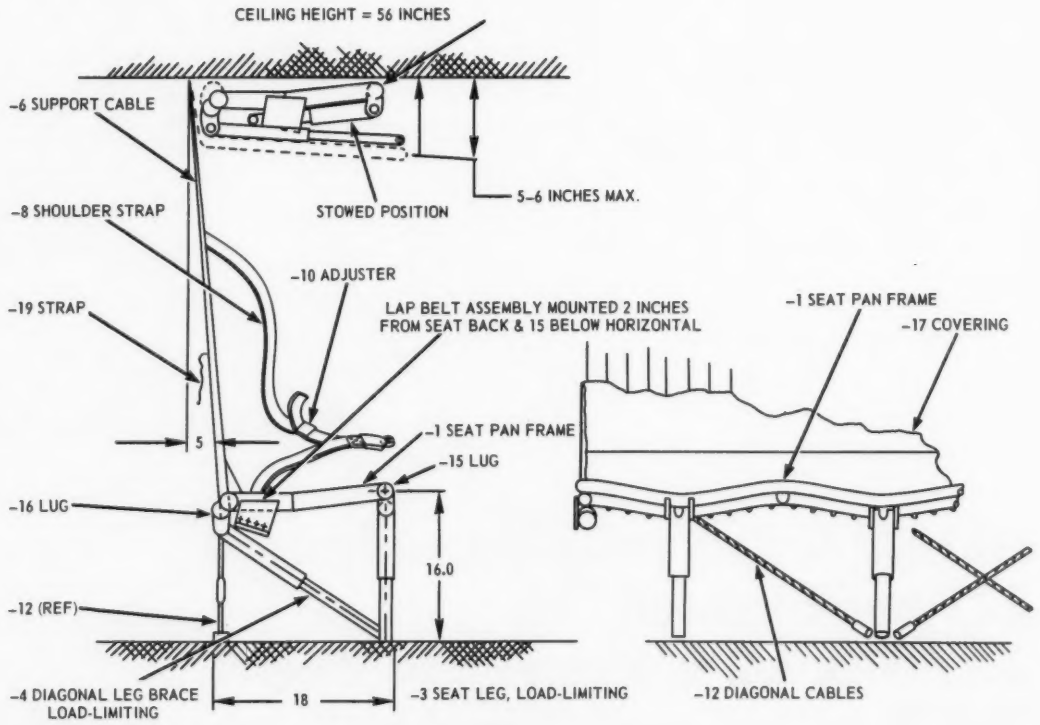


FIGURE 2

Rear-Faced, Four-Place Troop Seat, Side View

With these features in mind, let's discuss the details of the two troop-seat designs USAAAVS proposes for the UTTAS. Figures 1 and 2 show drawings of a rearward-facing design. A forward-facing design is illustrated in figures 3 and 4.

Key desirable features of the rearward-facing design are ceiling and floor supports, optimum resistance to forward g loads, light weight, ceiling stowage and automatic reel-in harnesses. Mounting seats to both ceilings and floors provides lightweight seats because conventional floor-mounted seat overturning loads are eliminated. The backs of the seats are supported by energy-absorbing stainless steel cables sandwiched between nylon net coverings. Stabilized seat-pan supports are attached to floors by deformable load-limiting legs. These deformable legs are designed to stroke downward and, at the same time, resist sideward deflection. The National Aeronautics and Space Administration has already developed and tested this type of leg in airline passenger seats.[1]

Stretchable steel cables and diagonal load-limiting braces both resist forward movement. These load-limiting devices permit seats and backs to deflect forward when excessive forward g loads are applied. Seat legs pivot at top and bottom to permit a parallelogram movement of seat pans, relative to seat legs and floors. This pivoting concept has also been developed and tested by NASA on an airline passenger seat.

Although the sideward restraint provided by the rearward-facing seat design is not ideal, the diagonal shoulder strap provides some sideward restraint and torso friction against the seat back resists sideward movement in most crashes. The total of these forces should provide adequate sideward restraint.

Cable-supported seats appear ideal for ceiling stowage because the small cables used can be flexed to permit their use as collapsed-seat retainers at ceilings.

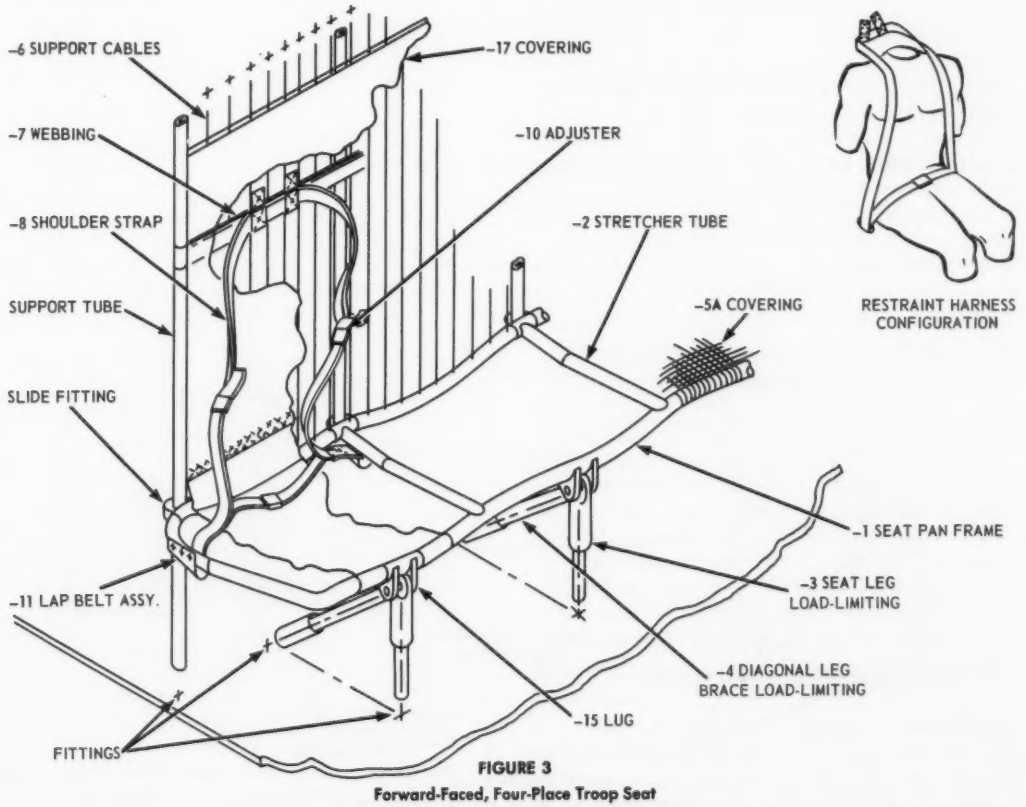


FIGURE 3
Forward-Faced, Four-Place Troop Seat

UTTAS TROOP SEAT DESIGNS

Ceiling stowage appears to be a major advantage because the entire cargo floor is left clear for loading.

Convenient stowage is an obvious but important advantage of retractable lap belts. Easily located, these belts can be quickly locked and unlocked. A commercial reel-in lap belt already in use in automobiles can, with slight modification, be used for aircraft troop seats. The use of automatic reel-in lap belts would eliminate conventional length-adjustment fittings.

The forward-facing seat illustrated in figures 3 and 4 uses most of the components of the rearward-facing seat design. However, it requires columns (tubes) between floors and ceilings to support concentrated loads from shoulder straps. The diagonal cables (–12) shown in figure 2 are not necessary for forward-facing seats because the sideward loads can be sustained by the vertical tubes and the diagonal leg brace (–4) is relocated so that it attaches to the front, rather than the rear, edge of seats. The advantage of this design over the rearward-facing design is that it provides improved forward visibility for seated troops. The primary disadvantage is the fact that the 5-foot vertical tubes complicate stowage problems.

Both designs offer the significant advantage of increasing occupants' chances of living through survivable accidents. Each design limits loads for a 265-pound occupant along these axes:

Forward—12 g load through a stroke (deformation) of 10 inches at seat pan level.

Lateral—10 g load through a stroke of 5 inches at seat pan level.

Vertical—10 g load through a stroke of 10 inches.

This combination of restraints is expected to provide occupant protection in 95 percent of all survivable crashes.

After troop seat designs have been selected, the seats must be arranged in fuselages with enough

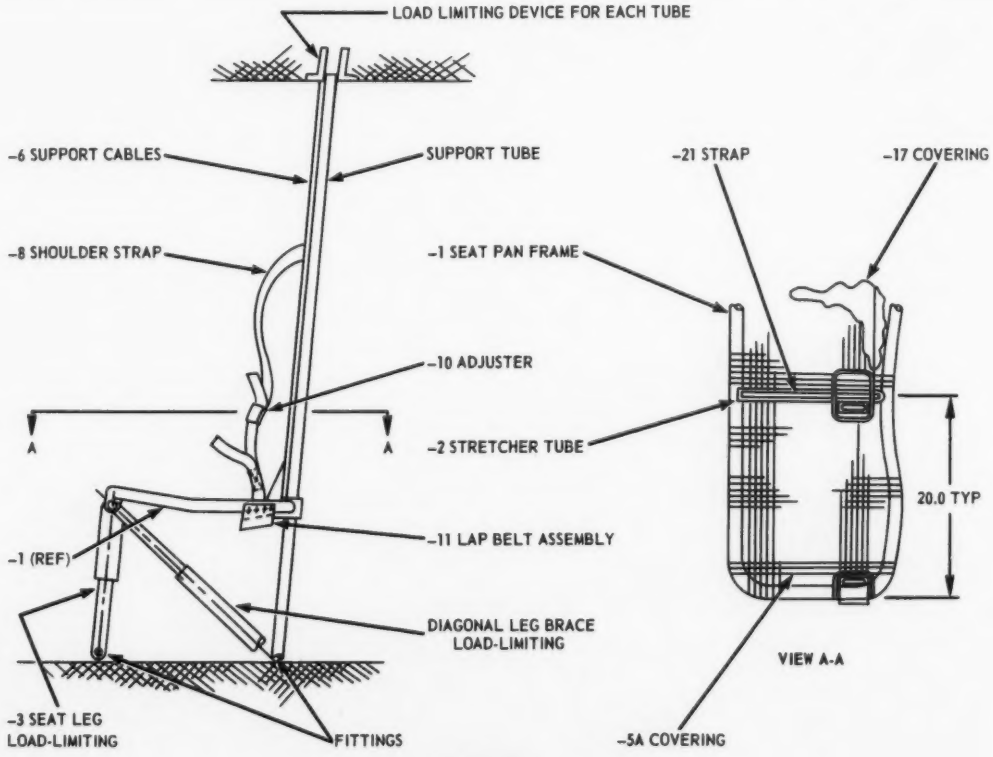


FIGURE 4
Forward-Faced, Four-Place Troop Seat, Side View

clearance to permit occupants to enter and exit aircraft rapidly, under both normal and emergency conditions. In addition, sufficient clearance to keep occupants' heads from hitting fuselage structures must be provided in the sideward direction. If, because of other design requirements, sideward clearance is not feasible, padding of the side structure becomes of paramount importance. Many seat arrangements are possible and feasible, but these constraints, together with those of floor plans, numbers of occupants, ingress and egress times, total weights, final costs and crashworthiness, limit the number of practical arrangements. With these limitations considered, USAAAVS proposes the seating arrangement shown in figure 6. This arrangement meets UTTAS troop payload requirements and offers the following desirable operational and crashworthy features:

• An aisle width of 8 inches on either side of the fuselage that would permit movement in the aircraft during flight. This aisle width would be available only if the floor width is 96 inches. A floor this wide would enhance the utility of the aircraft by providing ample cargo space, as well as room for sideward seat deformation.

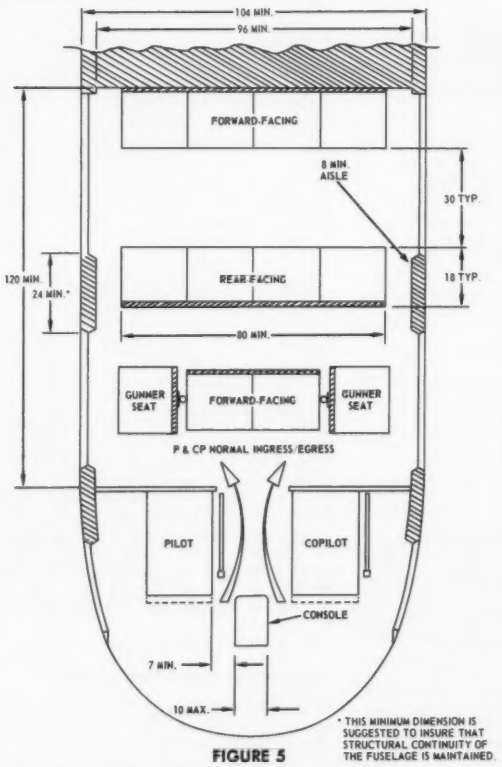


FIGURE 5

Suggested UTTAS Seating Configuration to Achieve Satisfactory Crashworthy and Operational Factors

• Two large passenger doors on each side of the aircraft, for both normal and emergency use. The forward door would be about 40 inches wide and the rear door about 48 inches wide. These widths would be ample for troop ingress and egress and for easy cargo loading. The front door could be a split level door, with the lower half hinged at floor level, and the upper half designed to roll up to ceiling level in a manner similar to a roll-top desk. Details of a feasible split level door are shown in figures 6 and 7. Note that the lower hinged door is only 2 feet high. This low profile permits it to be opened in flight, before an aircraft touches down. The upper door, constructed of thin metal extrusions, hinged at the edges, would slide upward in tracks to provide a complete opening, with no reduction in height. The hinged door could be used as a loading platform or personnel loading step. Armor plate could be attached to the door's inner surface for the protection of door gunners. Two gunner seats[2] are shown on column mounts near the forward doors in a sideward-facing configuration. The rear door could be designed to slide rearward on tracks, as do cargo doors in the UH–1s. The large forward and rear doors would permit four people to exit simultaneously from both sides. These doors should be tapered toward the inside of the aircraft to help prevent binding during deformations which sometimes accompany crashes. In those accidents in which a helicopter comes to rest on its side, personnel on the low side would be able to climb up to the high-side doors via floor-to-ceiling seat webbing.

• Individual emergency exits for pilots and copilots on either side of cockpits. In addition, pilots and copilots could use the forward passenger doors for emergency exits because the position of the instrument console in relation to the pilot and copilot seats and the collective control stick/device in this design permits easy ingress and egress for pilots and copilots. Easy passage to and from their seats via the cabin area would be possible if sufficient clearance were allowed in this area. While an extra long collective stick, such as that in UH–1D and H models, would hinder passage, the location of the console and collective device shown in the drawing could provide adequate access.

• Fuselage structural integrity provided by the two-door arrangement which allows for a 24-inch bulkhead down each side of the aircraft. These bulkheads would contribute to fuselage shell integrity dur-

ing rollovers and stiffen the structure. Research of utility aircraft accidents indicates a definite need to reduce the size of the "barn door" in this type of aircraft.

As a result of the USAAAVS study, the following basic guidelines for design and development of practical and feasible UTTAS troop seats were developed:

1. Rearward- or forward-facing troop seats in the UTTAS would improve crashworthiness.

2. A rearward-facing, cable-supported troop seat (figures 1 and 2) has the potential to provide maximum restraint at minimum weight, stowage space and cost, and should be developed further.

3. A forward-facing, cable-supported troop seat (figures 3 and 4) is also worthy of further development.

4. The inherent elongation capability of ductile metals should be used in troop seat designs as much as possible.

5. Load-limiting methods, either separate devices or the inherent plasticity of ductile metals, should be used as much as possible in troop-seat designs, because the controlled deformation provided can reduce seat tiedown loads, as well as g forces imposed on seat occupants.

6. The desirable operational and crashworthy features afforded by the troop-seat arrangement and door designs shown in figures 5, 6 and 7 should be incorporated in developmental programs for troop-carrying aircraft.

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1. National Aeronautics and Space Administration, *Comparison of Seat/Dummy Loads With and Without Load-Limiting Devices in a Standard Airline Triple Seat,* AVSER Memo Report 68–10, 1968.
2. Details of the gunner seats are the subject of USAAAVS Technical Report 72–7.

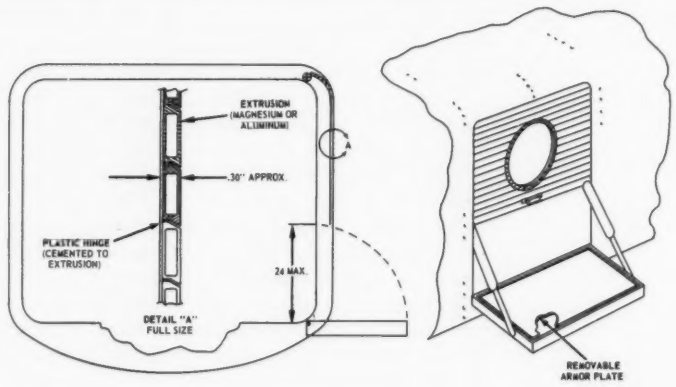


FIGURE 6
Proposed Split-Level Door at Forward Position. Hinged Lower and Roll-Up Upper Door

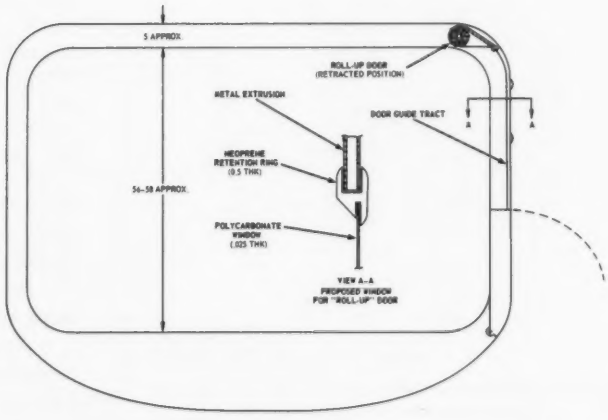


FIGURE 7
Detail of Roll-Up Door Retracted to a Spiral Position

EIRs

Reference is made to the November 1971 issue of AVIATION DIGEST and article on page 43 covering EIR reporting. Review of this article indicates omission of propellant-actuated devices, FSC 1377, from EIRs. Since propellant-actuated devices are a major part of life-support systems, it is recommended that they be referenced as a major area for EIRs. Frankford Arsenal, Philadelphia, Pennsylvania, is the Army Commodity Center for these devices, and EIRs should be directed to this agency to the attention of Q1000. —Acting Chief, Systems Engineering Office, Frankford Arsenal

Thank you for filling in the missing information. It was an oversight on our part.

AVIATION ACCIDENT PREVENTION FORUM

an interchange of ideas between readers and USAAAVS on subjects of aviation accident prevention

Flight Records

USAAAVS receives so many requests for flight records from individuals who are no longer in the Army that we thought it might be helpful to publish a word of advice to:

AVIATORS: Keep your copy of the 759 forms given you every year. Although a copy of this form is usually sent to USAAAVS, there is no guarantee that we can Xerox this copy for you. The copy we get isn't kept indefinitely. We extract data from it that is then coded into our data base. Even though certain information is available on a computer read-out, we probably won't have what you yourself need. USAAAVS will provide you some information concerning orders and checkouts, but the majority of this information is available only in your individual flight record file. This file is kept by appropriate commanders who forward the flight record folder with DA Form 201. In other words, where the DA Form 201 goes, there goes the individual flight record file. After you leave the service, it should end up at one of the national record centers.

NONAVIATOR CREW MEMBERS: Make sure you have all the information you may need about your flight hours, orders, etc., before you retire or are discharged.

Readers are invited to participate in this forum. Send your ideas, comments and recommendations to USAAAVS Fort Rucker, AL. 36360

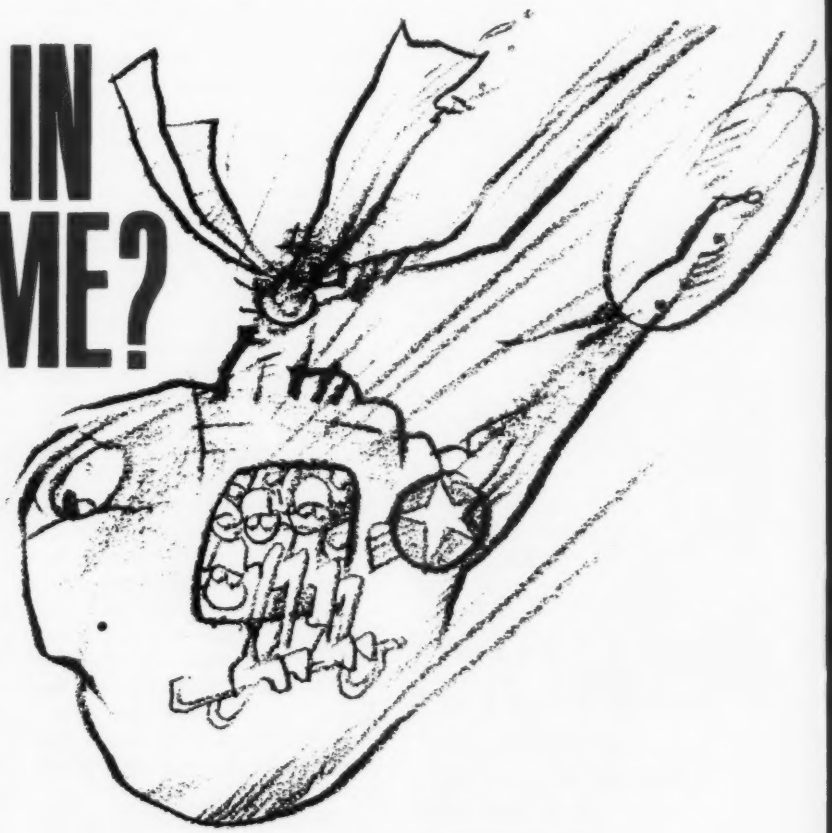
USAAAVS does not receive completed DA Forms 759 and 759–1 for nonaviator crew members. Your flight records remain in your unit, and according to AR 95–64, they are forwarded with your 201 file when you leave the unit.

Safety-of-Flight Messages

Re safety-of-flight messages: How long are they effective, and how are they terminated? In other words, how does the user identify current messages and those no longer in effect?—Air Safety Specialist

USAAVSCOM is responsible for issuing safety-of-flight messages. These messages are electrically transmitted and consist basically of two types: Those that change or eliminate operational procedures and those that prescribe inspection criteria (time frame and method of accomplishment). After the TWX is sent, AVSCOM then publishes a change to the TM–10 if the problem is with an operational procedure. If the message deals with a required inspection, then a change to the TM–20 or a TB/SB is published. The TB/SB and the change to the TM each identifies the safety-of-flight TWX that it follows and carries the annotation that the TWX is thereby rescinded or superseded. After a unit receives the TM change or the TB/SB, the TWX may be destroyed. When a new TM is published, the changes are incorporated.

WHAT'S IN A NAME?



David T. Forbes Jr.
Aircraft Accident Analysis & Investigation Dept.
USAAAVS

THE EXPRESSIONS *power settling* and *settling with power* are common and often used interchangeably. What do they mean? To what phenomenon in helicopter dynamics do they refer? Are they identical? Similar? Different? Both contain the words *power* and *settling,* but the arrangements are different. One has *power* before *settling* and the other has *power* after *settling.*

Perhaps a review of helicopter manuals will provide an insight, an answer or a definition of *power settling* and *settling with power.*

Let's start with the U. S. Army Technical Manual 1–260. On page 2.13 we find: "Under such conditions (see note 1), the helicopter descends in turbulent air that has just been accelerated downward by the rotor. Reaction of this air on rotor blades at high angles of attack stalls the blades at the hub (center) and the stall progresses outward along the blade as the rate of descent increases."

Note 1: "Conditions likely to cause 'settling' are typified by a helicopter in a vertical or nearly vertical descent (with power) of at least *300* feet per minute and with a relatively low air speed. Actual critical rate depends on load, rotor rpm, density altitude and other factors. The rotor system must be using some of the available engine power (from 20 to 100 percent) and the horizontal velocity must not exceed 10 knots."

Hmmm! Would you say, an aerodynamic principle of "settling through your own air mass"?

Federal Aeronautics Administration Advisory Circular 61–16A discusses *settling with power.* "This

condition of flight is sometimes described as settling in your own downwash. It involves high vertical rates of descent and the addition of more power produces an even greater rate of descent. The helicopter is descending in turbulent air that has just been accelerated downward by the rotor. Reaction of this air on rotor blades at high angles of attack stalls the blades at the hub (center of the rotor) and the stall progresses outward along the blade as the rate of descent increases."

WELL! So far, so good! Both manuals sound similar in their descriptions. Let's make a change of pace.

A fine booklet, *Sikorsky Helicopter Flight Theory for Pilots and Mechanics* by John R. Montgomery, 1964, elaborates on this phenomenon. On page 81 we read: "No discussion of power as it applies to helicopter operation would be complete without mention of a phenomenon known as *power settling.* At high altitudes, high gross weights, or when operating with reduced power, it may not be possible to maintain level flight due to a lack of power. The resulting settling of the helicopter is not too important except at certain combinations of rate of descent and low air speed. When operating at these combinations, the attendant power settling becomes critical.

"Aerodynamic analysis of power settling shows that when a critical power settling condition occurs, roughness and a degeneration of control effectiveness results. As we have seen from previous discussions, rotor downwash approaches maximum values when the helicopter is at or near the hover. Under certain power and rate of descent combinations a vortex ring flow state occurs through the rotor. Vortices are built up at the tips of the blades and in the center of the rotor. A gigantic recirculation of air takes place in and around the rotor. The helicopter settles into the air mass its rotor has just displaced in its attempts to produce adequate lift. The blades attempt to maintain efficiency but fall short of the desired goal because they are working in their own turbulence.

"In extreme power settling, the velocity of the recirculating mass becomes so high that full collective pitch and power will not produce sufficient thrust to slow down or control the rate of descent."

WOOOPS! Some description, but now the handle has changed. *Settling with power* has become *power settling.* Can we find *power settling* elsewhere?

NAVWEPS 01–230 HMA–1 (NATOPS, flight manual, CH–53A helicopter) uses the term *power settling.*

"POWER SETTLING

"At high altitudes, at high gross weights, or when operating with reduced power, it may not be possible to maintain level flight and settling will occur. The helicopter sinks into the air mass it has just displaced in trying to obtain lift, and the rotor blades are working continually in their own turbulent airstream. The attendent settling is of minor consequence, although at certain rates of descent and forward speeds, roughness and a partial loss of control may occur and be indicated by ineffectiveness of the controls. Recovery from this condition is not readily made by increasing collective pitch and power. This will only reduce rotor speed or prolong the condition." See notes 2 and 3.

Note 2. The NATOPS, flight manuals, CH–34D and SH–3A (Sikorsky), and CH–46 (Boeing) use the same label, *power settling,* to describe this phenomenon.

Note 3. No reference to *power settling* or *settling with power* was found in the Army dash 10s for the UH–1D/H, OH–6, OH–58 and TH–13T.

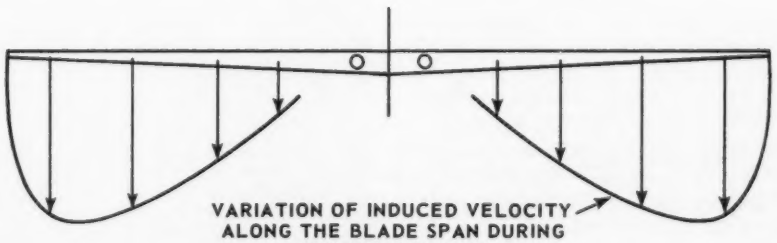


FIGURE 144

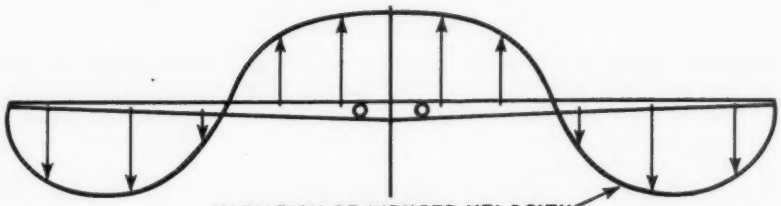


FIGURE 145

Let's recap quickly. The phenomenon—settling in your own air mass—is apparently named *settling with power* by the Army and FAA. The Navy and Sikorsky seem to call it *power settling*. Wonder what other publications say? Interesting! The Army CH–47 dash 10 names the phenomenon as *settling with power*, but the CH–54 dash 10 uses *power settling*.

The Air Force label is a mix also. The Bell UH–1 dash 1 refers to *settling with power*. Sikorsky HH–3 and Haman HH–43 use *power settling*.

The problem then is nomenclature. All the publications essentially describe the same helicopter aerodynamic phenomenon. *(Note 4:* TM 1–260 and FAA AC 61–16A describe the phenomena as a blade *stall* condition. This is somewhat in conflict with that aerodynamic reference *Fundamentals of Fixed and Rotary Wing Aerodynamics*. For descriptive simplicity, the *stall* story is adequate.) It is the label used which seems to be the problem. Let me now refer to *Part 1, Fundamentals of Fixed and Rotary Wing Aerodynamics*, produced under DA–04–225–AV1–1734, to help resolve this conflict. Page 260 commences the discussion and is labeled *power settling*.

"POWER SETTLING

"The normal flow in the form of the velocity distribution across the rotor is shown in figure 144.

"The maintenance of this velocity distribution will depend upon sufficient power being available to provide the thrust to support the weight. If the helicopter begins to settle upflow will begin to prevail at the center of the rotor and spread outward. Figure 145 depicts this situation.

"As the upflow imposed upon the rotor of a descending helicopter is uniform across the rotor, the influence will be felt first at the hub. If the helicopter continues to descend under the above conditions of insufficient power, the helicopter will enter a vortex ring state of flow.

"The vortex ring state of flow is depicted in figure 146. [This] figure shows that the rotor blades are not stalled during vortex ring state flow. The roughness and loss of control experienced during power settling are the result of the turbulent rotational flow on the blades and the unsteady shifting of the flow out and in the spanwise directions along the blades. There is an area of positive thrust on the outer portions of the rotor and negative thrust in the center. The net thrust on the rotor is zero or approximately so.

"The power settling has been used to describe many flight conditions of the helicopter. True power settling occurs only when the helicopter rotor is operating in the vortex ring state. Many cases of so-called power settling are merely settling with insufficient power."

A final note: Recovery from *power settling* is accomplished by:

1. Increasing forward speed (dive) or
2. Decreasing collective (autorotation).

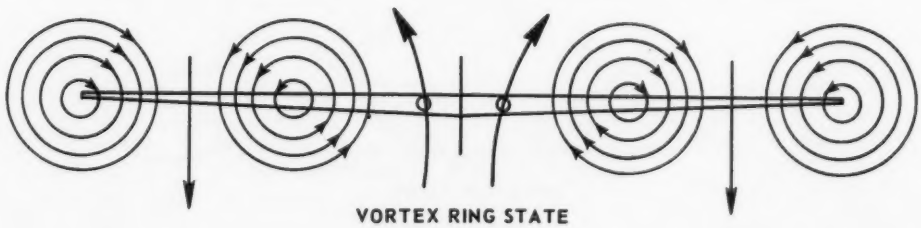
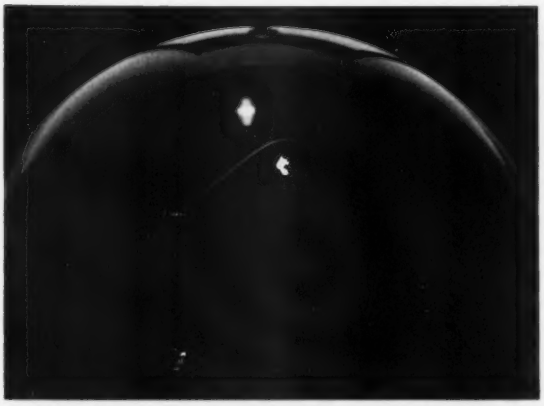


FIGURE 146

(cont'd from page 51)



cleaning is necessary, wash with soft cloth and sufficient water to prevent scratching. Then use a mild glass or plastic cleaner. Take proper care of your helmet so it can take care of you.

If you have a question about personal equipment or rescue and survival gear, write Pearl, USAAAVS, Fort Rucker, AL. 36360

From Bioenvironmental Safety, January 1972:

VARIATION IN MK–13 MOD 0 DISTRESS SIGNALS

Several reports have come in concerning Mk–13 Mod 0 day/night distress signals (Mk–13 Mod 0 marine smoke and illumination signals) which lack the familiar three bumps on the plastic cap of the night end. The caps of these signals do, however, have a flange around the edge which can be used to identify the "night end."

According to the Naval Ammunition Depot, Crane, Indiana, the lots containing these flares were produced under Air Force contracts. These were Contract N104–8311A (lots 2–HK–0965–104 through 50–HK–1265–104) and Contract N00104–68–C–3458 (lots 1–KC–0668 through 40–KC –0868 with the exception of lot 35–KC–0868). To insure that all fleet units are informed of the existence of these signals, NAD Crane has recommended to the Naval Air Systems Command that an Interim Aviation Armament Bulletin (IAAB) will be prepared indicating the proper means of identifying the night end of these signals and the lots involved.

USAASO Sez

The U. S. Army Aeronautical Services Office discusses

What Is A DARR? How many of our readers know what a DARR is? An extinct bird like the DODO? A NOTAM abbreviation? A new R&R Center? Of the few who know, how many could tell us who their DARR is and where to find him? Many of you might say, Who or what the devil is that?

A DARR is the Department of the Army Regional Representative representing Army interests in each Federal Aviation Administration (FAA) region. DARRs are assigned to the U.S. Army Aeronautical Services Office—USAASO (you-say-so)—with offices in the FAA regional headquarters. A typical DARR office consists of one lieutenant colonel, one CW4, one master sergeant and a secretary. Officers in these assignments are dual-rated, instrument-qualified Army aviators and most are current examiners. The senior enlisted men have extensive training and many years of experience in air traffic control.

The primary mission of the DARR is to provide commanders with professional guidance in airspace matters and to coordinate the Army's interest with the FAA regional office, but the total sphere of interest of the DARR includes all matters within his regional area which affect Army aviation. He is there to provide you with SERVICE. The DARR can help you secure needed aeronautical charts and publications, help with your air traffic control problems, aid in procuring and maintaining NAVAID equipment, coordinate aviation problems with FAA, Air Force, Navy and other interested agencies, help evaluate airfield sites and obstructions, assist in special use airspace procedures, assist in preparing for IG inspections, and even serve as an instrument examiner if necessary.

The DARRs are continuously involved in DOD Flight Information Publication (FLIP) problems as well. They monitor NOTAMs and send in corrections if necessary, submit comments and report new and changed corrections to the FLIPs, provide information to area commanders on what flight publications are required, and how and where to secure them.

Army aviation units returning from Vietnam and the growing National Guard and Reserve organizations will find the DARR particularly helpful. Get to know your DARR. Don't miss the airboat if you have ATC or airspace problems. Contact YOUR representative with the FAA.

Eastern/New England Region
LTC Joseph P. Morris
JFK International AP
Jamaica, NY 11430
Aut 938-3696 or
AC 212-995-2870

Rocky Mountain Region
CW3 Virl D. Martin
10255 East 25th Ave.
Aurora, CO 80010
AC 303-837-3796

Southwest Region
LTC John J. Peppard Jr.
P. O. Box 1689
Fort Worth, TX 76101
Aut 885-1533 or
AC 817-624-4911

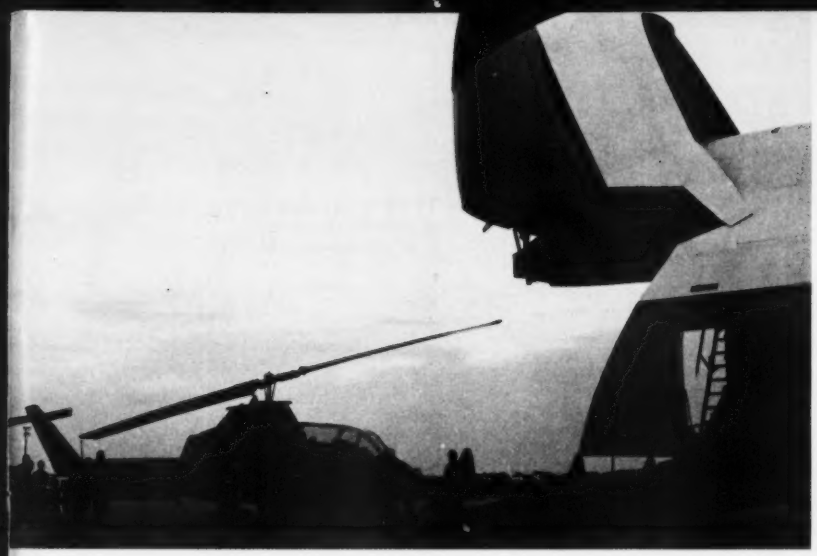
Great Lakes Region
CW4 Carl E. Lorence
3166 Des Plaines Ave.
Des Plaines, IL 60018
AC 312-296-1161 EXT 3358

Southern Region
LTC William D. Phillips
P. O. Box 20636
Atlanta, GA 30320
Aut 431-1767 or
AC 404-526-7245

Northwest Region
CW4 Kent A. Mosser
FAA Bldg, Boeing Field
Seattle, WA 98108
AC 206-767-2610/2611

Western Region
LTC John L. Holladay
5651 W. Manchester Ave.
Los Angeles, CA 90045
Aut 898-3875 or
AC 213-776-6440

Central Region
LTC Norman J. Hughes
601 East 12th St.
Kansas City, MO 64106
Aut 886-3831 or
AC 816-374-5576



Galaxy Loaded

Above left, an Air Force C-5A Galaxy assumes kneeling position for onloading an AH-1G HueyCobra. Above, the AH-1G is eased aboard world's largest airplane. Below, members of the 82d Airborne Division seem to have room to spare as they practice onloading procedures

PFC John Martin

Photographs by SSG Ronnie McCumber
82d Airborne Information Office

DURING FEBRUARY members of the 82d Aviation Battalion of the 82d Airborne Division at Ft. Bragg, NC, participated in a series of tests, the purpose of which was to examine various methods of loading and offloading the USAF huge C-5A "Galaxy" aircraft. Many benefits were realized including the opportunity to orient the troopers and familiarize them with the loading procedures.

The men of the 82d loaded a quantitative mass of equipment into two of the mammoth planes. Equipment included: 4 AH-1G Cobras, 2 OH-58 Kiowas, 2 UH-1H Hueys, 2 CONEXs and 29 passengers. Into the second plane the troopers loaded 2 "Charlie" model gunships (UH-1C Hueys), 2 AH-1G Cobras, 2 OH-58 Kiowas, 3 CONEXs, 1 ¼ ton truck with trailer, 2 ¾ ton trucks with trailers and another 29 passengers.

The men were instrumental in testing effective tiedown techniques, as well as checking the efficiency of rubber floor mats in preserving the skin of the aircraft without hindering the loading and offloading process.

Although the results of these tests are still being evaluated, one fact stands out. The C-5A Galaxy, whose load capacity of 161,000 pounds equals three loads of a C-141 "Starlifter" and immensely increases the capabilities of air transport. Equipment once believed to be transportable only by land and sea can now be moved by air, thus giving U.S. military divisions increased capabilities for worldwide deployment in the accomplishment of any assigned mission.

. . . that commanders at all echelons discourage pilots from flying in marginal weather conditions for the sole purpose of returning to home base . . .

See accident #3 on page 39